

March 2, 1959

Aviation Week

Including Space Technology

Nationwide
Weather Radar
System Planned

McGraw-Hill

McGraw-Hill Publication



McDonnell 119 Turbojet Utility Aircraft

Report on Nuclear Ramjet Development



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All-metal self-locking nuts

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AVIATION CALENDAR

March 12—Symposium on Macromolecular Technology for Composite Systems, Department of Interior Architecture, Wafangdian D-D Spandex Information Systems Branch, Office of Naval Research

March 16-17-Spring Conference, Lubrizol
Chem Division, American Society of
Mechanical Engineers, Foodline Institute,
Philadelphia, Pa.

March 23-24—Flight Testing Conference,
American Rocket Society, Dryden Flight
Hud. Center, Rosam, Mo.

Public Coast Section of the Society of the Plastics Industry, Hotel del Coronado, San Diego, Calif.

AVIATION WEEK including Space Technology

[illegible]

...and the ...

Example: From year 1975 to 1980, the number of people in the United States who were aged 65 and over increased by 10 million.

ANALYSIS NOTE, March 2, 1988



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AVIATION CALENDAR

(Continued from page 5)

- Refueling Laboratory of the Goddard Space Research Institute of the Air Force, Cambridge Research Center, Research Hotel Boston, Mass.
- Apr. 11-14-1977 Nuclear Congress, Mass. and Ashmole, Cleveland, Ohio. For information: Engineers Joint Council, 29 West 38th St., New York 18, N.Y.
- Apr. 14-15-1977 National Military Industrial Conference, Palace Square, Chicago, Ill.
- Apr. 15-16-1977 Fuel No. 781 Gas, Wall Street, New York, N.Y.
- Apr. 15-16-1977 Annual Meeting, American Association of Airport Executives, Savannah, Ga.
- Apr. 17-18-1977 International Conference on Physics, Massachusetts Institute of Technology, Cambridge, Mass. Sponsors: Air Force Office of Scientific Research, Solid State Sciences Division, Office of Naval Research, National Science Foundation, National Academy of Sciences/NRC (Coastal Dr. Daniel C. Palmer, National Academy of Sciences, Washington, D.C.)
- Apr. 17-19-1977 Future Arms a World Congress of Flight, Las Vegas, Nev.
- Apr. 18-19-1977 Conference on Nuclear Safety, Hotel Statler, New York, N.Y. Sponsors: General New York Safety Council.
- Apr. 18-19-1977 Annual Meeting, American Tool Training Society, Denver, Colo., Las Vegas, Nev.
- Apr. 18-19-1977 Annual Conference in State of Radio Engineers Conference and Electronics Show, Dallas National Auditorium, Dallas, Tex.
- Apr. 21-22-1977 Technical Conference on Electronic Data Processing, General Motors, Engineering Society, 1000 Congress Plaza, Chicago, Ill.
- Apr. 21-25-1977 Annual Convention of International Airline Navigation Council, Hotel Manhattan, New York, N.Y.
- Apr. 22-24-1977 Annual Meeting, Institute of Environmental Engineers, Exhibit the 1st Chicago, Ill.
- Apr. 21-24-1977 Quarterly Regional Meeting, Association of Local and Territorial Airports, Bellvue Hotel, Denver, Colo.
- Apr. 18-19-1977 Controllable Servicing Conference, American Rocket Society, Vaux, University Institute of Technology, Cambridge, Mass.
- May 4-6-1977 International Electronic Conference, Institute of Radio Engineers, Belmont Hotel, Dayton, Ohio.
- May 4-7-1977 Annual Flight Test Society Symposium, sponsored by the Instrument Society of America, Seattle, Seattle Olympic Hotel, Seattle, Wash.
- May 10-11-1977 Regional Conference and Trade Show, Institute of Radio Engineers, University of New Mexico, Albuquerque, N.M.
- May 11-12-1977 Electronic Components Conference, American Institute of Electrical Engineers, Institute of Electrical Engineers, West Coast Electronic Manufacturer Association.
- May 6-11-1977 Annual National Forum, American Telegraph Society, Statler Hotel, Washington, D.C.



Avco/Crosley Falcon Air-to-Air Missile. (Photo courtesy of Avco/Crosley)

Avco/Crosley

Crosley And the Falcon Air-to-Air Missile

Avco's Crosley Division is a major contributor to the production of one of the country's most important air-to-air weapons, the Falcon missile. Crosley's manufacturing facilities, its skilled personnel and its willingness to see the job through, on schedule and according to specification, again has won it a contract to produce stabilizer and trigger assemblies for the Falcon.

For the same reason—skill, quality, and willingness to meet difficult schedules—Crosley Engineering Ltd. is doing important work on another missile, the U.S. Navy's Polaris.

Crosley has to its credit other unique tasks that assisted in the development of Jupiter, Sergeant and Redstone.

CROSLY'S COMPLETE CAPABILITIES

Together with its associated Avco Division, Crosley provides facilities and personnel for:

- Equipment systems management from initial concept to production
- Production and manufacturing for missiles and aircraft systems
- Research, development and engineering of new systems, air traffic control systems, instrumentation, automatic test and support equipment, ground handling equipment and logistics.

For additional information, write to: Vice-President, Marketing-Defense Products, Crosley Division, Avco Manufacturing Corp., Cleveland, Ohio.



World's largest brazed steel honeycomb panel



Produced by Rohr to test manufacturing feasibility, this 6 by 12 foot panel represents a giant stride toward meeting the structural demands of modern flight.

A variety of structural inserts and external fittings, such as might be required in actual production units, have been incorporated.

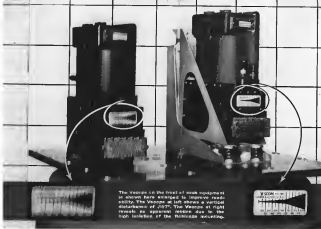
Manufactured to highest possible loading standards, the construction of such a panel is perhaps the severest path through the thermal barrier confronting today's designer of aircraft and missiles.



Busy building the biggest and best in honeycomb structure.



MAIN PLANT AND HEADQUARTERS: CHULA VISTA, CALIF. PLANT: ALBUQUERQUE, CALIF. DIVISION: PLANT: NORFOLK, VA. AUSTIN, TEXAS



The Vibrotron on the left of shock equipment is shown here mounted to improve readability. The Vibrotron on the left shows a vertical distance of 200". The Vibrotron on the right reveals an apparent motion due to the high isolation of the Robinson mounting.

12.0 "G" reduced to 0.6 "G"

This Is Environmental Protection!

Look at the above illustration, showing two Bendix air data sensors on an electromagnetic shake table. Notice the left hand unit which is mounted solidly to the oscillating base of the shaker. The image is blurred because a vibratory input of about 287" double amplitude at 35 c.p.s., equalling an acceleration force of 12 "g's", is being applied directly to it.

Now look at the right hand unit mounted on a Robinson appliance mounting system... some difference! The clear image of this equipment shows the typically high isolation efficiency (over 95%) of the Robinson MET-L-FLEX® mounting design.

Other Robinson designs provide similar protection at higher frequencies where the input often reaches 30-40 "g's". The natural frequencies of such mounting systems are held within limits which are not critical to the equipment.

Utilizing this mounting system radically reduces the environment to a level easily tolerated by any reasonably well designed electronic equipment. Such a mounting eliminates the need for costly and time consuming ruggedization. Over-all space and weight are held to a minimum.

Because of the proven performance and reliability record of airborne components now protected by Robinson mountings, an increasing number of manufacturers in the electronics industry are interperating Robinson mountings as an integral part of their basic equipment design.

"Performance is the reason... Reliability the Result"

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West Coast Engineering Office: Santa Monica, Calif.

DESIGNERS AND MANUFACTURERS OF VIBRATION CONTROL SYSTEMS



A. J. Mikes, left, supervisor, reproduction department at Westinghouse jet engine plant, Kansas City, and G. J. Lammert, machine engineer, examine a series of offset paper masters that change in a continuous roll at the rate of 20 feet a minute from the Xerox® Copyflo® II destination printer. Background: The Copyflo printer has cut Westinghouse's storage and its printing a matter from 40 to 75% more, and more uniform lines and energy to other paperwork duplicating applications.

Westinghouse of Kansas City Saves \$35,000 yearly

A Xerox® Copyflo® II continuous printer—obviously xerography at its brilliant best—has reduced the cost of preparing office paper masters by nearly 40%, and stepped up reproduction capacity 25 times at the Westinghouse jet engine plant, Kansas City.

In so doing, the Copyflo printer is saving cost, time, high-quality, paperwork reproduction at a faster rate than the division ever attained previously by any other method.

The Copyflo continuous printer is saving Westinghouse \$35,000 yearly. Recent changes in plant operations that will permit greater uniformity of the Copyflo printer are expected to double those savings.

Prior to its installation, the cost of preparing an office paper master, for instance, was approximately 43 cents. Now it is 85¢ cents.

Westinghouse previously could run out only 200 masters a day. Recently, it prepared \$17 in one hour on the Copyflo printer.

Reproduction work at the Aviation Gas Turbine Division in Kansas City consists largely of forms, drawings, engineering drawings, change orders, and specifications. An important part of the volume is the reproduction of operational logs, at which 100,000 to 140,000 a month are turned out.

Of special worth to Westinghouse is the speed with which engineering drawing changes now reach production lines. Changes are distributed sooner, thus saving immediately in machining operations.

A Copyflo continuous printer is an automatic copying machine operating on the electrostatic principles of xero-

graphy to produce dry, positive prints of office paper master ready for reproduction use. The prints are continuous—uninterrupted, reduced, at the same time—emerge from the printer at the rate of 20 feet a minute on a 3,000-foot continuous roll 11 inches wide.

Wherever fast and accurate copying of thousands of different documents is the need, look to the Copyflo continuous printer for the happy solution. For full details write Halazon Xerox Inc., 99403, Elwood Street, Rochester 3, New York. Branch offices in principal U.S. and Canadian cities.

**HALAZON
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WHO'S WHERE

In the Front Office

Thompson Range Welding, Inc., has elected the following operating executives of TRM's Thompson Products divisions, Cleveland, Ohio, its vice president: **Robert T. Angell**, engineering manager, Toys Group; **Robert E. Gossings**, manager, Thompson Products Valve Division; **William M. Jones**, manager, Thompson Products Commercial Electronics Group; **Carl L. Kohler**, manager, Thompson Products Industrial Division.

Eng. Gen. John W. Carpenter, III, commander, Edwards Air Force Base Flight Test Center, Calif. Gen. Carpenter replaces **Col. James Cooper** now assigned to the Federal Aviation Agency.

D. E. Maguire, a doctor, United Air Lines, Inc., St. Margaret, is now vice president/transportation services.

William C. Reynolds and **Joseph H. McCann**, executives vice president, Reynolds Metals Co., Richmond, Va.

Isaac K. Dwyer, now president, Lockheed Corp., Cupertino, Calif.

Myron L. Dwyer, vice president/Western Division, and **Robert C. Malley**, assistant secretary, Collins Radio Co., Cedar Rapids, Iowa.

Howard Green, now president, Cadillac Corp. Co., subsidiary of E. C. O. Corp., Detroit; **Mark M. Gans**, a general manager, Coda Metal, Inc., specialist.

Louis B. Zinner, now president/manufacturing and **Dr. Leonard C. Moore, Jr.**, now president/manufacturing-director, Ciba-Geigy, Inc., New Brunswick, N.J.

Klaus E. Auerbach, vice president, Fujitsu Support, Inc., Mahwah, N.J.

Honors and Elections

Dr. John Mason, chief of polymer design for The General Corp.'s Adhesives Division, has been appointed to the National Aeronautics and Space Administration's Advisory Committee on Mechanical Power Plant Systems.

Henry Egan, president of International Electronic Research Corp., is now president of the Strategic Industries Assn., Los Angeles, Calif.

Frederick L. Holman, chief of engineering research and general aviation division, Gulf Aircraft Corp., has been appointed to the National Aircraft Standards Committee of the Aircraft Industries Assn.

Changes

R. J. Lombard, assistant to E. H. Heston, now president-director, qualified as chief systems engineering, Douglas Aircraft Co., Inc., Santa Monica, Calif.

G. W. Tushnet, military advisor to the group for product definition and special projects, Chrysler Corp., Detroit; **Rich L. Kohn**, head of the newly formed Instrumentation and Communications group of General Electric's Missile and Space Vehicle Department, Philadelphia.

(Continued on p. 37)

INDUSTRY OBSERVER

► Escape systems tests for the National Aeronautics and Space Administration's Mercury-Mercury-Space project already have begun under direction of Langley Research Center. Wind tunnel and loading system tests began last October. NASA has awarded Thiokol, Inc., \$140,000 for XM-1561 rockets for escape system.

► Gyrodyne drone helicopter under evaluation by Navy for use as an airborne detector will be used primarily as a "kill" weapon against submarines. Navy will rely upon detection detection gear to find the submarine, then launch the drone carrying weak explosives in an effort to compensate for the World War II detector's lack of speed in addition to that of a nuclear submarine. Designation of helicopter under evaluation are the single-engine D5N-1 and twin-engine D5N-2. Powerplants being used are modified Pacer submersible engines.

► Fourth bidder for Army's Mauler anti-aircraft weapon system (AW Feb. 9, p. 21) is The Martin Co. The first bidder sent contractors since they originally had had Phase I study contracts for the system. Award is expected within the next future. Other three bidders are General Electric, Canine and Sperry.

► First three squadrons of General F-105 interceptors are scheduled to go into operational service late this spring at early summer at McGuire AFB, N. J.; Geiger AFB, near Spokane, Wash.; and Andrews AFB, Md.

► Third try for the ballistic missile early warning system (BMEWS), which the U.S. Air Force would like to locate near Perthick, Scotland, has become the subject of a diplomatic dispute between the U.S. State Department and the British Foreign Office. USAF believes the third try is necessary for maximum effectiveness of the missile detection system. The British consider the site a prime target in case of war and are reluctant to grant permission for its installation.

► Lithium, one of the lightest but most reactive metals, is not being overlooked by Air Force researchers as a possible structural material for future space vehicles. ARDC scientists have not established its tensile strength at 64 psi. And although used as hard solder oil to prevent it from hardening into flake, the feeling is that it might prove serviceable in the next various of space.

► Bureau of Aeronautics has begun procurement of beryllium wire for use in a reinforcing element in new composite aircraft structural members.

► Navy plan to incorporate some anti-submarine "SEF" potential into its Polaris fleet ballistic missile submarines—probably the Salvo underwater-torpedo-in-water-torpedo long range weapons now being developed by General Atomics Corp.—to avoid necessity of having to supply each system with accompanying filter submarines for protection.

► General Electric is flight testing another new aircraft—the "Yenta-1" built at the Northern Polytechnical Institute. The single-engine monoplane has a top speed of 121 mph, and a ceiling of 31,400 ft. It can carry four to five passengers and also can be used for sports flying and agricultural work.

► Under present planning, Navy will eventually have a total of 31 ships equipped with either the Convair F-44 or Convair F-444, guided missiles. Twelve ships will include the F-444, a multi-engineered missile, two F-444s, one missile, a destroyer and 19 frigates. Twelve ships will include these causes and 18 destroyers.

► De Havilland of Canada has increased the gross weight of the DHC-4 Caribou from 24,000 to 25,000 lb. to provide a greater payload and lengthened the cabin by 45 in. to accommodate an added row of seats which boosts passenger capacity of the aircraft to a total of 39.

Propulsion through the ages...



Pseudomonas aeruginosa isolated from J. H. de Witte et al.

the ascending process¹. In 1784, just a year after the invention of the balloon, the Frenchman J. B. M. Meusnier composed of an aerial embodying the essentials of the modern dirigible. Research the gas bag being a gasdole connected across. There was a rudimentary rudder and three manually-operated propellers. A proper power plant was lacking, however, and perhaps that is why the dirigible never and a dream for another century. A few decades of index are more instructive. The

have the proper paperwork available, and have the right propellers in them, intense turbo-prop power packages. The Russian people, for example, designed, developed and produced the propellers for the first turbo-prop aircraft and now supply over 100 aircraft and aircraft agencies around the world who assess 10 Russian Helicopters. Russian turbo props are standard equipment on the Vahana Vintenn, Fockhild F-27, Graciosa Gulfstream and Europa Rotocraft.

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Washington Roundup

ARDC Shakeup

Watch for a major challenge in Air Research and Development Command after the naming of a new commander to succeed Lt. Gen. Samuel Anderson who was recently promoted to command Air Materiel Command. Considerable work for ARDC streamlining will be done outlined in the Sleave report prepared by a special committee led by Dr. Geoffrey Storer, former Air Force chief scientist and professor at Massachusetts Institute of Technology (AW July 16, p. 24). One of the biggest problems facing ARDC is reduction of its headquarters staff and planning mission capabilities. The experience of other research centers at base level of the air services is critical.

New Bid for ABMA

Also look for the National Aeronautics and Space Administration to make another significant advance in space exploration. The Agency's Ballistic Missile Agency at Huntsville, Ala., before the end of the year, is studying a concept for the Boreas and Seara space network, which, during the past few years, NASA administrator Keith Gernert has pointed to the feasibility of work a transfer. Gernert says he has sketched a responsive cloud in Congress where he said NASA requires the capability, to assemble and ground test space vehicles and to improve subsequent launching operations. To build such an enterprise with the private facilities Gernert says, would require considerable funding while the transfer could be accomplished at relatively low cost.

However, Army resistance to such a transfer is not expected to diminish.

NASA Information Policy

In another area, professional staff members at both the House and Senate space committees are reconsidering the possibility of an inquiry into the public information policies of the National Aeronautics and Space Administration. The act creating NASA directs the agency to provide the "widest practicable and appropriate dissemination of information concerning its activities and the results thereof." Complaints involving staff members indicate that top officials seem reluctant to make public plans and progress of the agency.

Jet Surcharge Approved

[illegible]

Penalty Plan

Legislation setting penalties of up to a \$10,000 fine and a year's imprisonment for participants in Civil Democratic Board cases who violate all-the-record communications to CMB employees or members has been introduced by Rep. Owen Harris (D Ark.) as a follow up of a study of the openness of regulatory agencies by House Commerce Committee which he heads (AW Jan. 12 p. 29).

Even if the intent is not serious, CAA members and employees would be required to place all communications in a public file. If the communication is oral or telephoned, a summary would be filed. Failure to file also would be subject to a penalty up to \$10,000 fine and a year's imprisonment. Harris' source also would

- Establish a detailed code of ethics for Board members and employees
 - Provide for selection of the chairman and vice chairman by Board members, instead of by presidential discretion
 - Require that one Board member represent or personally direct the preparation of each Board division. The member responsible would be identified in the division
- Meanwhile, Haver is setting a \$200,000 appropriation to continue the coordination of CAB and other regulatory agencies by a Commerce subcommittee which will lead over this year.

In Congress

Meanwhile, in other Capitol Hill action

- Nuclear snafu.** Rep. Albert Thomas (D-Tex.) is suing Air Force to replace its nuclear aircraft project from General Electric Co. and plant it with a new contractor. Thomas is chairman of the appropriations subcommittee on defense, Atomic Energy Commission. GE and its subsidiary, Westinghouse Electric Co., have been awarded the Joint Atomic Energy Committee in Atomic Energy this year. "The time comes when a change is warranted," Thomas declared. "General Electric has been waiting on the project for eight or nine years. Sometimes when one man can't do a job, another man should be given a try." GE is chairman of the Joint Atomic Energy Commission's subcommittee on research and development, but, after dispute with Thomas, saying "I see no cause for complaint with the contractors on this project," he commented. "They have met every schedule that has been set, and the price is a fair one. I don't think it is fair to say they have slipped a lock at it or become of the contractors."
- Gun town.** Rep. Wilbur Mills (D-Md.), chairman of House Ways and Means Committee, is opposed to President's proposal to increase the tax on the gift of guns. He said the tax on the gift of guns is 4.5 percent on net fair. Mills' opposition means the tax on the gift of guns has little chance of congressional approval. He is not yet convinced in a levy of two cents a gallon on oil paid, new tax law.
- Radio squabble.** House has voted the Commerce Committee \$150,000 for a comprehensive study of the radio spectrum and policy on the need of frequencies. Architects object to the relative responsibility of the agencies by government units. Air Transport Association, American Radio, Inc., now have a court case pending against the Federal Communications Commission, claiming that the commission was wrong in its decision.

—Washburne still

ARPA Seeks 1970-80 Missile Defenses

Anti-gravity, anti-matter, radiation weapon concepts to be studied in search for long-term solutions.

By James A. Fraw

Washington—Concepts that are aimed at providing essentially complete defense of the United States against ballistic missiles in the up-to-1980 period between 1970 and 1980—including anti-gravity, anti-matter, and radiation weapons—will be investigated in a study program sponsored by the Advanced Research Projects Agency. Constraints will be let early next month.

Basically, the program is an attempt to break away from the present environment of engineering laboratories in solutions to the ballistic missile defense problem, and to find better fundamental approaches to a longer term solution. Funds available for the program total \$15.5 million, about 4.5% of ARPA's ballistic missile defense budget.

The program is known as GLIMP, standing for Global Laser Interdiction Program, for Anti-Matter, Beam, and Plasma. It will last nine months. It will consist of six months of study by some 5-10 contractors of possible advanced defense techniques, one month for preparation of technical summary reports, and a final two months involving meeting where representatives of the individual contractors will combine their efforts into a "single coherent solution" to provide a base for action by ARPA.

Some strengths have indicated non-satisfaction of such concepts as anti-gravity, for missile defense, ARPA estimates, however, that the GLIMP program is an attempt to break new scientific thinking from conventional approaches to the missile defense problem so that all potentially applicable physical mechanisms can receive one-proposed consideration.

Physical barriers received a beating in the GLIMP program of the Pentagon Feb. 10 from personnel at the Ballistic Missile Defense Branch of ARPA's Institute for Defense Analysis. About 50 major defense and electronics companies plus several university groups attended.

One of ARPA's responsibilities is research and development leading to advanced capabilities in ballistic missile defense. Phase I of the GLIMP program is aimed at setting out initial goals for research to develop such capabilities over the 12 to 15 years in the future.

The thrust for this period is defined as one essentially "theoretical" nature defined at the Cleveland State University specifically on matter traveling along a path which is in part or essentially ballistic. The destructive potential of the thrust is not limited to nuclear warheads.

The contractors to be sought

would come close to being totally effective in penetrating the thrust from matter, or in intercepting it. Three essential characteristics basic advantages to the defense operation will have the highest effect. The objectives of Phase I are to identify and assess various ideas to the extent of defense mechanisms which have maximum potential.

The program will not require development of technology. Instead, it will require research in detailed studies, some projects that a particular technique is not feasible. Approaches which appear to be valuable and which one can be proved not feasible, will be left for further consideration.

Proposals for Phase I must be submitted to ARPA by May 30. The nine-month study contracts to be awarded will each involve approximately 500 man-months of highly concentrated physical mechanisms. The proposals will be examined by an advisory committee made up from the Army, Navy and ARPA, with ARPA making the final selection of some 5-10 contractors about April 3.

The first six months of each contract will be spent in study in the individual researcher's laboratory. Each will have the freedom to select the mechanisms in physical phenomena for possible devices to be examined—and each should expect to examine closely some 5 to 15 possibilities, according to ARPA.

The basic conservation laws of physics will be applied to develop those that cannot of the mechanisms studied which will permit their evaluation for missile defense. Engineering difficulties are to be of no concern in the studies, but the appropriate physical laws must be carefully fleshed out.

At the end of the sixth month each contractor will prepare a summary report covering the work accomplished thus far in respect to data and work.

The contractors will then provide

one representative each to participate in a working meeting that will last for a minimum of two months. This meeting will emphasize the individual results into a group evaluation to be used by ARPA as a basis for deciding on Phase II.

Phase I may indicate that the glial energy behind the Army's Nike-Zeus antimissile missile system—that of firing a rifle bullet to destroy a rifle bullet—is the only practical approach to missile defense for the foreseeable future. If, however, the program involves more promising approaches, ARPA will seek development of them.

Two questions appear to have been raised to the program. As the budget looms, a representative of the Bell Telephone Laboratories stated that he did not believe Bell would be interested in participating because the research's scientific on laboratory study appeared to be placing a time limit on achievement of a breakthrough.

Others pointed at the lacking ability to attract small contractors. ARPA stated, however, that only the space available for the working limited the number of contractors, and that unfilled proposals for projects which would be given equal consideration.

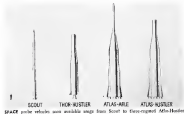
Cornell Studying High Power Radar

Buffalo, N. Y.—Problems of microwave propagation in long range missile tracking and development of new high power radar systems are being explored by Cornell University. The work is planned by Cornell University's Laboratory, under a \$1.5 million contract awarded last month by U.S. Army Contracting Corps, acting as contracting agency for the Advanced Research Projects Agency.

The program will be a continuation of high power radar studies originating with the Laboratory's work on the Photo Synthetic Aperture Radar (PSAR) system. The PSAR system is a laser 5100-3000 Å laser system which would be used for the radar. The radar program resulted in successful transmission of 10 million watts of peak power at 50-micron wavelength.

The new project will aim at transmission of peak powers as high as 50 million watts, with a variety of pulse lengths and aperture sizes. Average power will be in the 50,000 watt range.

Also included in the studies will be investigations of propagation of microwave power and the ability of future microwave radar to track objects in the tracking of subsonic aircraft.



Space Technology

U.S. Plan for Rocket Vehicles Includes Manned Flight to Mars

By Everett Clark

Washington—U. S. is planning a family of rocket vehicles for a variety of missions ranging up to a manned mission to Mars. All propulsion stages for vehicles in this long-range plan either exist now, or under development or in the feasibility study stage.

National Aeronautics and Space Administration officials outlined the plan to the Senate Committee on Aeronautics and Space last week.

Vehicles tested in the last of the three years will put satellites at up to 15,000 lb into a 22,000 mi orbit, put a 15,000 lb payload on the moon, and add a 55,000 lb payload to Mars, providing for a 25,000 lb return payload.

Vehicles in the order of payload capabilities, and roughly in the order of their complexity, are:

• **Project Scout**—150 lb. payload to a 300 mi orbit or human loads in lunar orbit. This is a 70,000 lb thrust liquid engine solid propellant vehicle now being developed by NASA (see story, p. 22).

• **Thor-Hustler**. This is the Douglas Thor missile booster plus Bell Aircraft Corp.'s Hustler engine, which was JPL-4 and now being retrofitted. It is in use in Advanced Research Projects Agency's Dismantle satellite vehicle program (AW Feb. 16, p. 30).

• **Atlas-Able**. This is the Conquest Atlas missile booster with the same upper stages used in Thor-Able vehicles—America's Vanguard second-stage liquid

boosted engine and Allgemey-Bell Laboratories' Vanguard third-stage solid propellant engine plus a payload stage. Under present plans, it will be used for the first time on June 4 in an attempt to send a payload into orbit around the planet Venus (AW Feb. 24, p. 26).

• **Atlas-Horizon**. After booster plus the Bell Hustler upper stage. This could put some 3,000 lb into a 300 mi orbit.

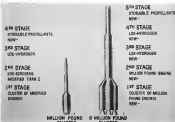
• **Vega**. This vehicle is now under development by NASA. It uses an Atlas first-stage booster, General Electric T-801 Vanguard liquid-stage engine, and a second stage. Initial Vega vehicle would consist of these two stages. Later version would use a 6,000 lb thrust solid

stage. This vehicle is up to five stages depending upon the mission, and based upon a cluster of four of the T-801s. Its thrust would be 150,000 lb. It requires new being developed by NASA's Rocketdyne. Second stage would be a single one of these engines. Third and fourth stage would be a new liquid engine and hydrogen engine and the fourth would be a solid-state liquid engine.

• **Vehicle using existing upper stage as stages**. The Atomic Energy Commission NASA Rover surface orbit project



CONQUEST space probe configuration is at left; Vega (right) is under ARPA development.



SEES of advanced boosters can be used by comparison with figure of area at base level

is aimed at eventually providing these stages.

They probably would be placed atop the six million lb stages.

Vehicle availability for putting man and payloads into orbit on sending them into space is expected to rise this way.

- 140 sq. in. solid—Vehicles can use per ap 100-150 lb and (rocket) available

can use over 2,000 lb. After wet stage—lightest could be Vega or Cetus—could push 7,400 lb. Gemini could add 14,000 to 15,000 lb. and Nova could add 150,000 lb.

- 22,000 sq. in. solid—first vehicle with this capability will be Atlas plus stage, with a payload of 1,500 lb. Saturn could add 3,500 lb. and Nova could add 42,000 lb.

- Linear loading—Vehicles available, some could add 150 lb. payload. Atlas with stage 750 lb., Saturn, 1,000 lb., Nova, 10,000 lb. The Nova would not be suitable for loading a man and returning him because payload drops to the vicinity of 2,000 lb. at a coasting trip.

- Main flight—Chemical stages, possible the Nova vehicle, could send 7,000 lb. to Mars and provide for returning 750 lb. A vehicle using solid stage would carry a 35,000 lb. payload to Mars, providing for a 25,000 lb. return—which should be enough to be the first time vehicle is used to allow for manned reconnaissance and return to earth.

The 1.5 million lb. single chamber engine, is expected to be available some time between three and six years from now.

In the time it is ready for use, these space stages are expected to be available in this order:

- 6,000-sq. in. thrust storable liquid engine under development by Jet Propulsion Laboratory.
- 15,000-sq. in. thrust liquid engine and hydrogen engine under development by Convair and Pratt & Whitney.
- 22,000-sq. in. thrust liquid engine and hydrogen engine now under study.
- 30,000-sq. in. thrust liquid engine now under study.

Space Technology

NASA Asks \$49 Million Supplemental

By Fred Eastman

Washington—National Aeronautics and Space Administration is requesting \$48,354,000 in supplemental funds for fiscal 1959—a figure more than \$3 million above the amount Congress finished for the 1959 budget last summer.

Supplemental estimates presented to the subcommittee of the Senate Committee on Aeronautics and Space include:

- Research and development, \$28,750,000 (all considered by NASA's external space flight program; Project Mercury Congress budgeted \$20,000 million for research and development; estimates from the fiscal 1959 budget last year, appearing \$50 million of the \$70.2 million requested).

- Construction and equipment, \$24,290,000, of which \$12.65 million is for new tracking facilities, \$1.2 million for propulsion development testing, in orbit and 50 million for other new facilities and modifications at the Jet Propulsion Laboratory, NASA's research and development center for its original fiscal 1959 budget request. Congress

reduced the figure by \$22.6 million to \$17 million.

Defense and agencies, \$1,114,000 in cover cost of new facilities provided by the Classified Pay Act of 1948. Congress approved 55 percent of the \$7 million requested last summer for fiscal 1959.

Congressional approval of the 1959 supplemental would give NASA a total of \$58,673,017 for the fiscal year, including a transfer of funds from the Defense Department totaling \$114,695,512. Of this, \$57.8 million was transferred from the Air Force, \$87.2 million from the Advanced Research Projects Agency, \$15,641,382 from Navy for the Vanguard satellite project and \$4,077,320 from the Army for Jet Propulsion Laboratory of California Institute of Technology.

Fiscal 1960 Estimates

NASA estimates for fiscal 1960 total \$48,354 million of which \$94,450,000 is for salaries and expenses, \$112,079,000 for research and development and \$17.1 million for construction and equipment. J. Keith Glendon, NASA's

administrative, said subcommittee chair Sen. John Stennis (D-Miss.) that additional funds probably would be required to meet the \$50 million supplemental appropriations request Congress has yet to take the fiscal 1960 requests under consideration.

Glendon added that, in his opinion, this would be the last year NASA would request a budget as small as one-half billion dollars. He estimated that the figure would reach \$2 billion in two years.

Two major projects now under way that will require substantial portions of research and development funds during the next few years, Glendon said, are Project Mercury and propulsion program.

Project Mercury already is budgeted at \$37,661,306 in fiscal 1959 and another \$20,734,800 is requested under the supplemental. Cost of the project in fiscal 1960 is estimated at \$20 million. Before the program is completed, Glendon said, the bill will have cost \$40 million.

The single-chamber 1.5 million lb. thrust booster under development by

with American Jetstream is budgeted at \$12 million in fiscal 1959 and \$30.2 million in fiscal 1960. Glendon told the subcommittee, however, before the single chamber booster enters a state of finalization, the cost will have exceeded \$20 million.

Total cost of the internal booster program to provide the heading block, sets of basic model engines required for the space program, Glendon added will exceed \$2 billion.

Out of the \$24,210,000 requested for construction and equipment, \$5 million is for new facilities and improvements to existing facilities at the Jet Propulsion Laboratory. A large part of this will be used to relocate various rocket test facilities and related equipment to a non-hazardous location where safety standards can be met.

At present, all but 10 of the 92 facilities on the laboratory site at Pasadena are non-compliant. Glendon said, modifications to existing facilities to meet changing requirements would be a major task.

Necessary test equipment will cost \$75,000. Reduction of utilities will add \$1,775,300. Allocation of test equipment \$1,919,300. Modernization of support facilities will cost \$2,257,000. Necessary test facilities will add \$1,053,000 plus \$1,500,000 for a new station and headquarters.

The largest new major construction and equipment in the \$24,210,000 requested for tracking facilities, which Glendon says are needed now because of the long lead times of much of the electronic gear.

Glendon told the subcommittee, even greater speed during the initial portion of the Minuteman electronic tracking stations in the international Geophysical Year program proved the need for improving and augmenting existing systems to provide more reliability and increased capability for tracking satellites in high altitude orbits.

New Tracking Stations

To accomplish these objectives it is planned to establish four new electronic tracking stations in the United States, Newfoundland and Europe and to install additional, improved equipment at some of existing Minuteman stations.

Requirements will include addition of real time digital data and out copy units and additional antenna arrays for coverage of satellites in high altitude orbits. It also will be necessary to shift the operation of all stations to a higher radio frequency since the 108 mc. frequency now used is topside.

To make the frequency change, reworking of all Minuteman radio receiving equipment and antenna arrays will be required.

Tracking and acceptance of telescopic data from space probes will require the

provision of special high-gain low noise receiving systems at several points on the earth's surface. One has been built at Goldstone, Calif., and funds are being spent for another one in Australia and the other in South Africa. Each station will include large parabolic antennas to pick up the low-level signals, sensitive radio receiving equipment and electronic hydraulic servo system for controlling the antennas.

Detailed studies of the problem of receiving signals from satellites, particularly reentry vehicles, Glendon said, will include the development of new test facilities at the second and third sites along the coasting Atlantic Missile Range complex.

Such operations will require the installation of precision radar systems, time tracking communication and associated systems at Bermuda in

order to provide accurate trajectory information on the vehicle after two weeks effort to establish that the satellite is in the desired orbit and to initiate abort action if needed.

Recovery of a manned satellite on the second and third orbit will require precision tracking during the re-entry phase, Glendon told the subcommittee. The hope is to provide precision radar navigation tracking communication and associated systems in Hawaii to provide orbital impact point prediction during the last phase of satellite recovery.

Emergency Control

Other three also will provide a capability for emergency command and control of satellites from the earth in the event of malfunctioning of the point beam system.

Glendon said still another precision radar acquisition, tracking communication

NASA Research, Development Programs—Fiscal 1959 & 1960

Program	Fiscal 1959 Supplemental Estimate	Fiscal 1960 Budget Estimate
AIRCRAFT, MISSILE AND SPACECRAFT RESEARCH		
Support of NASA plan	\$150,000	\$15,678,000
Support of JPL plan	\$1,180,000	\$1,176,000
Research contracts	\$1,100,000	\$1,100,000
SEE NTRC INVESTIGATIONS IN SPACE		
Scouting orbits	\$1,000,000	\$1,000,000
Earth satellites	\$4,000,000	\$4,000,000
Lunar probes	\$20,024,750	\$20,024,750
Deep-space probes	\$16,000,000	\$16,000,000
Unmanned exploration	\$2,944,250	\$2,944,250
SATELLITE APPLICATIONS INVESTIGATIONS		
Marine	\$4,000,000	\$4,000,000
Communication	\$1,700,000	\$1,700,000
SPACE OPERATIONS TECHNOLOGY		
Manuel space flight	\$7,661,200	\$20,734,800
Space machine techniques	—	\$4,000,000
SPACE PROPOSITION LABORATORY		
Small test rockets	\$700,000	\$700,000
High-speed test rockets	\$2,000,000	\$2,000,000
1 satellite ground test single chamber	—	\$2,000,000
Perigee	\$2,000,000	\$2,000,000
Nuclear rocket engines	\$1,000,000	\$1,000,000
Space engines	\$800,000	\$800,000
Assembly ground units	\$100,000	\$100,000
SPACE SYSTEMS TECHNOLOGY		
Advanced vehicle systems	\$800,000	\$800,000
Reentry systems	\$100,000	\$100,000
Orbiting space laboratories	—	\$200,000
SUPPORTIVE ACTIVITIES		
Tracking and data acquisition	\$4,800,000	\$4,800,000
TOTAL RESEARCH AND DEVELOPMENT	\$24,415,132	\$30,734,800

ness and associated system status is needed to track a nonreturning satellite between the eastern and eastern sides of the U.S. It is the first of the stations to be located in southern Texas and equipped for precision tracking of satellite launched northeast from Cape Canaveral on the first three orbits.

Cost breakdowns include:

- **Extensive and complex use of satellite electronic tracking systems** \$3.3 million. Of this, \$2,124,000 is for equipment and facilities for first three stations, including \$110,000 for antenna arrays, \$146,000 for electronic equipment and \$77,000 for one preparation and utilities. Another \$1,786,000 of the total is for modifications and improvement of existing electronic tracking stations, of which \$730,000 will go

for work of 12 stations to change radio frequencies, \$150,000 for digital radio equipment and \$300,000 for software arrays of 12 stations. Stations:

- **Facilities for space probe tracking network** \$1.5 million. Of this amount, \$1.9 million is for initial site preparation, roads, utilities and housing of two stations, \$970,000 for the first 16-ft. diameter antenna arrays, \$468,000 for two radio receiving units and \$700,000 for two antenna drive control systems.
- **Equipment for support of manned space vehicles** \$573,000. This includes \$1,718,000 for precision radar units for mission tracking and guidance, \$2,550,000 for precision radar for initial entry control and control and \$1,719,000 for personnel radar for mission and landing tracking.

Arrives West on Dec. 35 (p. 38) North American Aviation's Model D-150 will provide seven vehicles and a launch vehicle for a \$400,000 contract. This launch vehicle is expected to be the TX-33-27 Sergeant rocket used in Titan test vehicles will provide the thrust, being applied in pairs, and Titan-XM-101 Rocket motors will be arranged around the main rocket to provide a high initial boost. Sergeant contract is for \$2.2 million and will be through Army Ballistic Missile Agency. Rocket contract is for \$110,000.

The first phase program also includes a \$120,000 contract to ABMA-Thud for XM-47 escape ejection rockets.

- **Second phase of Mercury testing** will use Chrysler Redstone boosters equipped with capsules that will even amounts with, on later shots, possibly a man. Contract to Army Ordnance Missile Command for Redstone 1950 is \$4.45 million, with the final contract cost expected to reach \$15.5 million.

- **Third phase will use Chrysler Jupiter boosters** and also will include use of solid propellant and probably manned capsules. This is the third phase of the program. Contract to Army Ordnance Missile Command for Jupiter 1950 is \$2.74 million, total contract cost is estimated at \$4.45 million. ABMA will make a \$100,000 contribution to the Chrysler-produced Redstone and Jupiter.

- **Fourth phase will use Cosmic Atlas D boosters** the vehicle which will also be tested. This contract cost is \$1.5 million, but through Air Research and Development Command's Redstone Missile Division for Jupiter 1950, one for \$1.4 million and the other for \$1.4 million.

Contracts already awarded (see p. 44) will for use Atlas-A and two Thor-Abls (AWP Dec. 23, p. 26) and one improved Thor-Abls, as Atlas-A, being used by the Goddard Space Flight Center, will for use in 1959 and 1960 at least four to six times as boosters for satellites and space probes.

Contract for \$140,000 to Mississippi Research and Development Corp. for a rocket test system for Project Mercury, and contracts for rocket thrust chambers and testing and propellant tank assemblies for a liquid hydrogen rocket test program at Ames Research Center.

Also included is \$2.15 million for the delivery of a 100-ft inflatable sphere of plastic coated with aluminum which will serve as a passive communications satellite. Originally, the sphere was to be used as a test platform for a manned space vehicle, but project plan will for launching in 1960 with either a Thor-Abl or some improved vehicle.

Contract is with Army Ordnance Missile Command.

Scientific and technical studies

Prototype and operational hardware

Operations and technical services

Supplies, equipment, repairs, and alterations

Total

Program

AIRCRAFT, MISSILE AND SPACE CRAFT RESEARCH

Support of NASA, plan

Support of JPL, plan

Research contract

SCIENTIFIC INVESTIGATIONS IN SPACE

Scouting rockets

Earth satellites

Launch probes

Drop-payload probes

Vanguard program

INTELLIGENCE APPLICATIONS INVESTIGATIONS

Intelligence

Communications

SPACE OPERATIONS TECHNOLOGY

Manned space flight

Space operations techniques

SPACE PRODUCTION TECHNOLOGY

Solid fuel rockets

High energy solid rockets

Nonlinear in thrust single chamber engines

Nonlinear solid rockets

Space engine

Auxiliary power units

SPACE SYSTEMS TECHNOLOGY

Advanced vehicle systems

Rocket motor systems

Guidance space laboratories

SUPPORTING ACTIVITIES

Training and test operations

GENERAL RESEARCH AND DEVELOPMENT

MENT

*Functional breakdown not available.

Program	Scientific and technical studies	Prototype and operational hardware	Operations and technical services	Supplies, equipment, repairs, and alterations	Total
AIRCRAFT, MISSILE AND SPACE CRAFT RESEARCH					
Support of NASA, plan	1,100,000	1,100,000	1,100,000	1,100,000	4,400,000
Support of JPL, plan	1,100,000	1,100,000	1,100,000	1,100,000	4,400,000
Research contract	1,100,000	1,100,000	1,100,000	1,100,000	4,400,000
SCIENTIFIC INVESTIGATIONS IN SPACE					
Scouting rockets	50,000	50,000	50,000	50,000	200,000
Earth satellites	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Launch probes	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Drop-payload probes	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Vanguard program	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
INTELLIGENCE APPLICATIONS INVESTIGATIONS					
Intelligence	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Communications	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
SPACE OPERATIONS TECHNOLOGY					
Manned space flight	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Space operations techniques	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
SPACE PRODUCTION TECHNOLOGY					
Solid fuel rockets	100,000	100,000	100,000	100,000	400,000
High energy solid rockets	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Nonlinear in thrust single chamber engines	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Nonlinear solid rockets	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Space engine	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Auxiliary power units	200,000	200,000	200,000	200,000	800,000
SPACE SYSTEMS TECHNOLOGY					
Advanced vehicle systems	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Rocket motor systems	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Guidance space laboratories	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
SUPPORTING ACTIVITIES					
Training and test operations	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
GENERAL RESEARCH AND DEVELOPMENT					
MENT	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Functional breakdown not available.					

Space Technology

NASA Awards Scout Contracts

Washington—Contracts for the 70-ft, 14,000-lb. Project Scout rocket engine space rocket (AWP Dec. 23, p. 38) have been awarded by National Aeronautics and Space Administration, and Air Force in the process of selecting contractors for Scout's satellite component.

NASA and USAF will operate development with a joint team. USAF's vehicle-system 809A will differ from Scout in several respects.

Both are intended to be modular rockets with stages that can be used as various combinations. All Scout stages are solid propellant. With the possible exception of the third stage, all are of the first stage.

Scout will be assembled at Langley Research Center and fired initially from the nearby Polaris Launch Research Station at Wallops Island, Va. Auxiliary contract has not yet been awarded.

One Scout consists of four stages and could put 150 lb. into orbit or send a payload of about 100 lb. into altitude of 5,000 mi. It also will be used as high speed research tests. Stages and engines are:

- **First stage—August General.** Cope's Aermet Series with more than 100,000 lb. of thrust. This stage actually was called Jupiter Series when the Jupiter intercontinental stage missile was a joint Army-Navy project. At the time it was the largest solid rocket that had been fired. It powered an Air Force space vehicle. Contract is for two Scout stages, \$1,000,000.

- **Second stage—Thiokol Inc.** in proved Sergeant motor designated TX-33-20. Contract is awarded through Ames Research Missile Agency and will be \$620,000.

- **Third stage—Allgeier Ballistic Laboratory's X-24 engine,** a solid-propel-

ant of the X-245 first stage engine developed by the Vanguard satellite vehicle. Scout-AUG will be as high as three or four times the X-245's thrust, which is about 2,500 lb. Contract is through Redol and totals \$1,170,000.

- **Fourth stage—Allgeier's X-245 engine,** which will be used in Vanguard and has been used in Thor-Abls and USAF launch probes. Contract is through Redol, totals \$199,000.

The NASA program also includes a 800,000 contract for Thor-Abl-X-245 rockets. Some type of rocket will be used as escape stage in the Mercury manned capsule project. NASA has not explained what these would be in the Scout program, but it may be for spin substitution as command. Contract is all through ABMA.

Guidance and spin substitution contract for the fourth stage will be done by Mississippi Research Corp.

Rocket Contracts Let For Project Mercury

Washington—Contracts for rocket vehicles to be used in four phases of Project Mercury, including a solid propellant Little Joe vehicle for the first phase, have been awarded by National Aeronautics and Space Administration.

Another short designated Big Joe and using an Atlas, will be fired sometime this summer. Atlas will carry the first full-scale manned mission. It also has components of the manned capsule to be a tough haul on a solid-rocket booster to test it in orbit testing.

Little Joe in the transport vehicle for the first full-scale manned mission. Details of the vehicle and the concept of its operation were first revealed by

Arrives West on Dec. 35 (p. 38) North American Aviation's Model D-150 will provide seven vehicles and a launch vehicle for a \$400,000 contract. This launch vehicle is expected to be the TX-33-27 Sergeant rocket used in Titan test vehicles will provide the thrust, being applied in pairs, and Titan-XM-101 Rocket motors will be arranged around the main rocket to provide a high initial boost. Sergeant contract is for \$2.2 million and will be through Army Ballistic Missile Agency. Rocket contract is for \$110,000.

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Contract is with Army Ordnance Missile Command.

Scientific and technical studies

Prototype and operational hardware

Operations and technical services

Supplies, equipment, repairs, and alterations

Total

Program

AIRCRAFT, MISSILE AND SPACE CRAFT RESEARCH

Support of NASA, plan

Support of JPL, plan

Research contract

SCIENTIFIC INVESTIGATIONS IN SPACE

Scouting rockets

Earth satellites

Launch probes

Drop-payload probes

Vanguard program

INTELLIGENCE APPLICATIONS INVESTIGATIONS

Intelligence

Communications

SPACE OPERATIONS TECHNOLOGY

Manned space flight

Space operations techniques

SPACE PRODUCTION TECHNOLOGY

Solid fuel rockets

High energy solid rockets

Nonlinear in thrust single chamber engines

Nonlinear solid rockets

Space engine

Auxiliary power units

SPACE SYSTEMS TECHNOLOGY

Advanced vehicle systems

Rocket motor systems

Guidance space laboratories

SUPPORTING ACTIVITIES

Training and test operations

GENERAL RESEARCH AND DEVELOPMENT

MENT

*Functional breakdown not available.

Program	Scientific and technical studies	Prototype and operational hardware	Operations and technical services	Supplies, equipment, repairs, and alterations	Total
AIRCRAFT, MISSILE AND SPACE CRAFT RESEARCH					
Support of NASA, plan	1,100,000	1,100,000	1,100,000	1,100,000	4,400,000
Support of JPL, plan	1,100,000	1,100,000	1,100,000	1,100,000	4,400,000
Research contract	1,100,000	1,100,000	1,100,000	1,100,000	4,400,000
SCIENTIFIC INVESTIGATIONS IN SPACE					
Scouting rockets	50,000	50,000	50,000	50,000	200,000
Earth satellites	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Launch probes	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Drop-payload probes	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Vanguard program	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
INTELLIGENCE APPLICATIONS INVESTIGATIONS					
Intelligence	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Communications	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
SPACE OPERATIONS TECHNOLOGY					
Manned space flight	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Space operations techniques	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
SPACE PRODUCTION TECHNOLOGY					
Solid fuel rockets	100,000	100,000	100,000	100,000	400,000
High energy solid rockets	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Nonlinear in thrust single chamber engines	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Nonlinear solid rockets	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Space engine	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Auxiliary power units	200,000	200,000	200,000	200,000	800,000
SPACE SYSTEMS TECHNOLOGY					
Advanced vehicle systems	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Rocket motor systems	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Guidance space laboratories	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
SUPPORTING ACTIVITIES					
Training and test operations	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
GENERAL RESEARCH AND DEVELOPMENT					
MENT	1,000,000	1,000,000	1,000,000	1,000,000	4,000,000
Functional breakdown not available.					

35,000-ft. Sled Track Tested

Bellman AF-400's Peter finally navigated its 15,000-ft. high speed sled track last week with a super speed of 100 mph, but with some and a 10 degree slide.

Test sled carrying the test was boosted to a speed of 1,000 mph by an Astronaut. Magdalen (solid rocket motor) that gives 100,000 lb. of thrust during its 10 sec. burn period. Sled traveled about 10,000 ft., coasting to a stop before it reached the water brake at the end of the track.

During the maneuver test, vibration characteristics of equipment aboard were tested and studies were made of a new solid chamber developed by Harold van Buren, technical director of the Astronautical Flight Laboratory. One of the tests was in response to rig in which it swung into a position where it

forces acted from early during acceleration. This means moving it to a new position to get the maximum effect during development. The second test was a head-on test, position to provide a new position. Both tests carried the test.

Astronauts used propellant boosters was one of a type using solid rocket motor that gives 100,000 lb. of thrust and slices of propellant are combined to provide the propellant needed for a particular test. This module approach is used for the test operation in providing scientists for the test booster precisely in the requirements of a particular test.

Astronauts have developed its capability for producing solid rocket motor, some rocket solid propellant gases through experimental program and through a JATO production program

which is now planning out of the company's McGraw-Hill, Inc.

Magdalen's test was to propel the sled was constructed of aluminum to test extended propellant segments as well as test specifications for the sled and to place in a position of the sled and plates.

Second Magdalen's motor has been used for test missions at Holloman in the past.

Booster used in the sled test last week was produced nearly two years ago by Rocket Propulsion Division of Phillips Petroleum Co. In this division was developed by Astronautical Laboratory of Phillips and North American Aviation. The 31 ft. 11 in. motor was loaded 2,000 mi. to track and stored under strong electric conditions before firing.

Magdalen's motor was 31 ft. in diameter, weighed 3,914 lb. weight and 4-60 ft. loaded.

development of advanced weapons is then such as CF-105 is two months for a nation of approximately 17 million people to undertake alone.

The government indicated its plan to be relying upon the Boeing B-70 were intercepter needed for the aerial defense of Canada under an arrangement whereby the U.S. would have two-thirds of the cost and Canada one-third.

Disagreement is in fact developed between the government and the company on several major points concerning the Avco program, particularly cost. The company said cost of production of 100 aircraft would be less than \$4 million each, the government put the cost at approximately \$7.5 million. "The government figures would be extremely challenged during the debate on a contract."

Another reason for the CF-105 cancellation, according to Dieffenbach, is that whereas the U.S. Air Force has decided not to continue with the fast-track development and production of U.S. aircraft leaving the same general performance in the Avco. During the debate in Congress, he identified the CF-105 aircraft as a Mach 3.160. Maximum speed of the F-105 is approximately Mach 2. The CF-105 has a potential at Mach 3.

Later in the debate, Dieffenbach, who said from Canadian newspaper and provided reports to media, noted in his points quoted an article which said

Intelligence Schism

Ottawa-Vancouver is Canadian government's adoption of intelligence on the Soviet Union and that the U.S. government apparently from the same information, because apparent during the time of Communist delivery of the Mach 3 Avco CF-105 intercepter. Minister of National Defense C.D. Foote said:

"All of the information we can get from the sources available to the government indicates that the threat of the Russian bomber against this country is diminishing." At another point, Foote told Congress that "the collection has been that the Russians are not maintaining the production of any type of bomber, even those that have been the code names of the Blue and the Black, and that the number of Blue and Black aircraft in the Russian inventory is extremely limited and, furthermore, that there are only two types of Soviet bombers which could reach this country and attack us."

The Defense Minister also challenged a statement by an opposition member of Parliament that military aircraft recently said that the Russians in the mid-1950s would still have an inventory of 1,800 to 2,000 bombers capable of striking Canada, in addition to its inventory of intercontinental ballistic missiles.

Foote replied that the statement "must not be taken as indicating that these 2,000 bombers could reach this country as that means that a great number of them would need to cross the Arctic flight route if they were successful."

U.S. military intelligence has reported that the Russians now have under development a supersonic bomber code named the Bomber. While USAF in 1957 issued a decision in estimates of Soviet production of the B-59 jet bomber after it became evident to the Russians that the aircraft would have a number of performance improvements, there has been little serious suggestion that the aircraft bomber design has diminished. Development of the Bomber apparently was designed to provide an effective replacement for the B-59.

Details and actual test flights of a prototype of a Soviet nuclear-powered aircraft was first reported by Aviation Week in an exclusive story last Dec. 1, (p. 27).

that the Avco was capable of speeds above 2,000 mph, but only at short bursts.

Its Mach 3 speed would place the Avco intercepter close to the general performance category of the Soviet Avrocar F-105, which is scheduled to be in development over the next several years.

It has been widely reported in Canada that the first Avco test flight with Pratt & Whitney J75 engines has approximately equaled the world speed record of 1,404.19 mph set by the Lockheed F-104. The fourth test flight Avco was scoring its actual flight data will be powered by General Motors turbojets which will increase the power available to 30% at altitude for approximately the same engine weight.

In discussing the CF-105 program, Prime Minister Dieffenbach said the program will add 400 to 500 jobs to the aircraft's top record and bring it to the Mach 3 speed range.

Meanwhile, after giving notice that the Avco and its foreign partners will reach this speed range of sonic travel or more, which is possible. It would be virtually impossible to combine a flight program in such as such stage as the Avco's engineering support and the government is not prepared to pay.

The government also indicates that it will not release that test data that has been collected but for because, without any Western power is interested in other the engine or the aircraft.

Finally, it feels that the information possibly could be a potential enemy.

Global location of the Royal Canadian Air Force to the cancellation of the CF-105 is taking steps in Canada which are the military in such a way public except through the evident number of the government.

However, Air Marshal Alan Stinson, RCAF's deputy commander of the North American Air Command, said he has support of the CF-105 public last November and was speech again available in Ottawa. Stinson said:

"We would be further in our duty to the military in such a way as to severely believe... I just gave best of my opinion. I am quite prepared to suffer the consequences because I believe I must be quite frank."

In discussing the CF-105 program, Prime Minister Dieffenbach said to another published report that the fighter's combat range was such about 500 km. He said that such a range did not mean that the aircraft would be able to attack at a distance as represented to the Canadian people.

Dieffenbach also said that the Avco would have a general squadron aircraft until 1965 which would be replaced by a new fighter which would represent the present threat to North America.

According to government estimates, Avco expenditures in some years of its development and production setback would have come close to 10% of the one-third defense budget.

Dieffenbach said that "the cost of the Avco program to Canada, as compared to the \$281 million for the CF-105, is approximately \$103.5 million. That represents something five times the cost of the Avco program, all things being equal and the defense program of the country are about the same."

Political thought in Canada now seems to range from a great fear that Canada will lose the sovereignty of it if it does not have the technical capabilities to develop its own weapons and does not pay completely for its own defense to beliefs at the other end of the scale that if the U.S. will not use these missiles in defense production, Canada should withdraw gradually from the North American defense picture and let the U.S. carry the burden alone.

Hicklet of the latter view point to that the U.S. troops have been so far in Europe, Germany for 12 years, with the U.S. paying a large share of the defense costs, and that none of these countries has lost its sovereignty. They said that steps to Canada to be taken by the government to develop a defense to the U.S. could then be regarded on the economic development of the country.

Dieffenbach and most of his supporters are putting a worse feeling be-

tween these two extreme views.

Anti-American feeling is being expressed in some quarters because USAF failed to show any positive action in the Avco program and several other Canadian projects. The Canadian government has been very vocal in its criticism. Thus, in however, as strong sentiment has developed, and most judgment probably will be received as the outcome of U.S. and Canadian public developments and the defense case.

Public dealings between the government and A.V. Roe was later after the contract termination. It included:

- A.V. Roe said it had no advance notice of the government's decision to cancel the contract.
- Dieffenbach said company management had discharged all its work in effort to reorganizing the government Avco and it had to discharge everyone and then refuse assistance to workers to strike by union agreements. The cancelled Avco-Canada payroll was around \$1 million a week, which meant employment levels of two weeks ago.
- Dieffenbach spoke at length in Congress about the Avco "loophole" and the severe pressure the company put on him to get the contract.
- Dieffenbach said the company had failed to propose any savings plan for alternative work of the Avco were cancelled.

The company replied that it had made no proposals which in one in the government would discuss.

Degree of misunderstanding existing was illustrated when the Prime Minister accepted a company proposal for a small budget to replace the Vincent. Dieffenbach said that the company had wanted \$10 million to get the program under way. A one-million dollar contract was offered to the government but later in risk considerable Avco funds in the development. He said its proposal had been to get a guarantee from the RCAF for the purchase of 25 of the aircraft. The price would be adjusted to that development costs would be amortized due to a production of 100 aircraft and the company would have the responsibility for selling the surplus.

Two meetings were held each last week between Dieffenbach and the A.V. Roe management. No statements were issued after the meetings except government sources that some work being employed to find employment for the Avco and Canada workers.

At the close of the fiscal year (Nov. 30), the company employed 72,000 workers, down 4,800 from a similar period in the previous year. Company said a further reduction in workers will be made in 1959, adding "this decline might be considerably greater than that in 1958, according to estimates based on present firm orders and letters of intent."

News Digest

Second Air Force-Martin Titan intercepter program has been cancelled. The program was cancelled last week from Cape Canaveral, Fla., over a \$50-180 million in the second objective of that program—preparation, guidance, and control intercepter. Four missiles already were delivered on this past phase, but two scheduled flights might cause a postponement of this part of the program.

Contracts totaling \$1.9 million for the Avco program have been awarded to Wallingford, Vt., and Ft. Churchill, Can., in 1959 and the first half of 1960 have been awarded to North American Aerospace Defense Administration. The division has been contracted with NRL for 52 million worth of instrumentation on 15 sub-100 and space planes that are to be built this year and next. Instrumentation will measure aircraft's magnetic field, atmospheric pressure, cosmic radiation, etc. NASA has awarded contracts to Hughes Aircraft Co., Los Angeles, and Hughes Aircraft Co., Los Angeles, for contract for design of two launch employment, a biohazard, and a strike test facility at Wallingford, Vt. Cost is estimated at \$2 million. Launch employment will be used to launch both liquid and solid propellant research vehicles.

Discoverer Aborted

Discoverer 40B-Second U.S. attempt to launch into a polar orbit in last Discoverer satellite vehicle was scrubbed last Wednesday only a few seconds before launch time. The abort came after more than four hours of "bake" of the fully fueled rocket. Although no final decision had been reached, the rocket engines encountered low heat because the abort was made. The abort was made because of the heat being caused by the liquid oxygen and the first stage during the launch.

A person attempt to launch the Discoverer last Jan. 22 was cancelled as a result of an inadvertent error by post-launch when the stage rocket was in effort to reorganizing the government Avco and it had to discharge everyone and then refuse assistance to workers to strike by union agreements. The cancelled Avco-Canada payroll was around \$1 million a week, which meant employment levels of two weeks ago.

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38 sounding rockets to be fired from Wallingford, Vt., and Ft. Churchill, Can., in 1959 and the first half of 1960 have been awarded to North American Aerospace Defense Administration. The division has been contracted with NRL for 52 million worth of instrumentation on 15 sub-100 and space planes that are to be built this year and next. Instrumentation will measure aircraft's magnetic field, atmospheric pressure, cosmic radiation, etc. NASA has awarded contracts to Hughes Aircraft Co., Los Angeles, and Hughes Aircraft Co., Los Angeles, for contract for design of two launch employment, a biohazard, and a strike test facility at Wallingford, Vt. Cost is estimated at \$2 million. Launch employment will be used to launch both liquid and solid propellant research vehicles.

Thailand Chemical Corp. directors last week voted to list at the Thai stock exchange capital stock, subject to stockholder approval on April 16. Split will be for stockholders of around April 20.

Convair Aerospace Division of Convair Dynamics Corp. has awarded a \$3.1 million contract to Atlas Intercontinental missile program support organization to develop a Convair Dynamics Intercontinental missile program. Equipment includes high pressure helium and nitrogen control systems used for checkout of Atlas pneumatic and fuel systems prior to launch.

Glenn Aircraft Division of Lear, Inc., has awarded a \$1 million follow-on order for convairable fighter to the Convair Aerospace Division. Convair Systems provides basic gyro reference and airborne computer for flight guidance.

Study contract in the field of anti-missile defense has been awarded to Selen Aircraft Co., San Diego, Calif., to be administered by Aerojet Ordnance Missile Corporation. Contract was awarded as result of a new approach developed by Selen and proposed to Advanced Research Projects Agency.

Riddle Airlines last week signed a preliminary order for four Armstrong Whitworth 618 Interceptor engine variants as an eventual replacement for its present fleet of C-47 low-capacity, high-altitude aircraft. The four variants will be delivered successively and the aircraft will sell for \$1.5 million each. Three of the series reportedly include 105-dw and six payments include the second and third variants. The company expects to be spent over a several period.



WEST COAST AIRLINES is operating its turboprop F-27s like the one shown, along with a fleet of 14 Douglas DC-3s.

F-27s Boost West Coast Revenue Miles

In first three months' operation turboprop aircraft increase revenue miles flown; gain new customers.

By William S. Reed

Seattle—Introduction of turbine equipment by West Coast Airline has in the carrier's three months' experience with the aircraft increased the number of revenue miles flown, attracted new customers and brought about a general expansion of business.

West Coast inaugurated its 40-passenger F-27 service September 1958, and produced some surprising figures for October, the first month of operation. During September, 1958, operation on certain selected routes, Douglas DC-3s carried 345 passengers per mile. During the first full month of F-27 operation the same routes yielded 848.5 passengers per mile, an increase of 45.76%. In passenger miles, the increase was from 1,861,248 to 1,576,778.

Increase resulted despite the normal seasonal decline in business experienced over fall since the airline started. West Coast said the first increase in business might have been due to the novelty of the F-27 and the fact that passengers might have dubiously imagined their children to fly in the new aircraft. However, the trend continued and seemed

figures show that, for December, West Coast's six F-27s flew 2,173,641 passenger miles.

Figures for actual cost per seat mile were not available since the company had too many uncertainties to consider in its accurate attempt to compute. Learning curve for all types of personnel from baggage handling to assignment is still in the opening and the truth and fact F-27 has not delivered until late November. West Coast's management believes, however, that the cost per seat mile will be favorable enough that, barring a general decline in the airline's revenues, its end to permanent subsidy could come in three years if the F-27 is not operated exclusively.

West Coast Airlines now operates its fleet of six F-27s and 14 DC-3s over a route of 2,200 mi., main-

ing some 30 stops. Recently Civil Aeronautics Board statistics also added via additional 1,600 mi. of route with 14 added stops. Average stage length is about 68 mi., with shorter legs being 25 mi., and longer 224 mi. Total stage length compared for the F-27 operation is about 125 mi., but this cannot be added unless dispatch authority is granted by the CAB.

This does mean West Coast could double its route to reach communities but before that aircraft would not stop at even stages on every flight, thereby ensuring the average stage length to more nearly approximate the optimum. One run West Coast pilots make around the state of Washington involves 16 stops. As a result, news become very pertinent in instrument approaches, landings and takeoffs, but stage lengths involved are not short.

Company Financing

West Coast has had financial success in its first year of operation, but its president, Nick Bick, through other business resources, was able to give considerable more collateral credit standing to the line.

Once the decision was made to acquire, West Coast obtained two \$1 million bank loans, one from a Texas

bank. An additional \$750,000 was raised by disposal of surplus assets and subscriptions to stock by corporate officials. Thus, West Coast is still in the position to avoid itself of a Civil Aeronautics Board guaranteed loan, should it become desirable to refinance and raise additional capital. Although \$4.75 million was raised, then needed for the purchase of six aircraft, capital was needed for purchase of training aids and anticipated expansion of routes.

Although new assets have been in service for short a time, to provide an definitive figure, company management is confident that the F-27s will be good revenue producers. West Coast sees the airplane as a means for getting the local revenue loss of subsidy.

F-27 Maintenance

Five bugs have shown up on the F-27, according to West Coast. Trouble involved wing failure in fuel pump, a pointed master bolt and nut which attracted cable leakage. Fuel pump and master bolt failure were eliminated by fast fire maintenance and nose wheel steering cable leakage was stopped when gear drive limit stand was temporarily lowered from 170 in. to 140 in. Fairchild Airplane & Engine Co. is developing fix on nose wheel cable leakage. Maintenance personnel are already under way in which Fairchild will send teams with vacuum kits to each user's base and perform work at specified intervals.

Another modification which affects the first time aircraft delivered to West Coast is the collar air conditioning blower. In flight, the blower makes an objectionable, high pitched whine. This was eliminated in West Coast's early airplanes but modification in the field will be necessary for the first five.

Staff member difficulty, reported in the passenger notices which opened the landing gear, nose wheel steering passenger entrance door and the wheel, landing and propeller handles. Master



WEST COAST's average stage length is about 68 mi. Shortest is 25 mi., longest is 224 mi.

world reflect around the pressure relief valve is the action during operation in the cylinders, where liquid already passed Seattle. East of the Rocky Mountains, the drive, roller chain caused the valve to freeze. This caused ice encrustations, but did not cause any damage. Kells River reported back to West Coast from its Canadian base to effect that the engine showed nothing more than normal wear.

One of the Rolls Royce Dart 5 turbo-prop engines on the West Coast F-27 was carried after a total of approximately 700 hr. engine/engine time. Russell was persistent, not due to failure, but due to that regularly scheduled engine overhauls for overhaul work could be diagnosed. Kells River reported back to West Coast from its Canadian base to effect that the engine showed nothing more than normal wear.

Baggage Bays

One other minor engineering change contemplated by West Coast is modification of baggage bays. Baggage was carried in two large bins forward of passenger cabin. These are slightly slanted, according to West Coast, but must be reworked. Anticipated fix is to install a shelf in each bin so that baggage must not be loaded in such fashion of short hands, it has frequently been necessary, in all bulk baggage to get at pieces which are on the bottom of the pile. Installing shelves is a simple matter, will eliminate shoring.

Some of West Coast's pilots were practically worn out on the DC-3 and, in fact, viewed the new F-27 with a com-

Comparison of Selected Flights

(including extra overhead)

	Total Passenger Miles	Per Mile	Per Mile	Percentage Increase
	F-27	DC-3		
(100 mi.) Seattle to Everett	121.7	78.1	plus 54.25%	
(100 mi.) Portland to Everett	125.4	44.5	plus 28.14%	
(100 mi.) Everett to Seattle	122.7	85.9	plus 42.84%	
(100 mi.) Everett to Portland	126.7	47.8	plus 12.62%	
(100 mi.) Seattle to Everett	126.6	45.4	plus 43.96%	
(100 mi.) Seattle to Everett	137.5	12.9	plus 47.84%	
(100 mi.) Everett to Seattle	111.5	35.8	plus 17.44%	
(100 mi.) Everett to Everett	66.2	12.9	plus 21.34%	
Total	840.0	343.0	plus 144.34%	

Aircraft Comparative Operational Statistics

December, 1978						
DC-3 Aircraft No.	Days	Revenue Per Flight	Non-Revenue Per Flight	Total Flying Hrs.	Avg. Daily	Avg. Daily No.
101	21	110.37	13.58	123.95	5.29	1.00
102	21	130.43	0.00	130.43	6.21	1.00
103	21	120.00	0.00	120.00	5.70	1.00
104	21	200.00	0.00	200.00	8.57	1.00
105	21	100.00	0.00	100.00	4.29	1.00
106	21	140.00	0.00	140.00	5.96	1.00
107	21	116.00	2.93	118.93	5.42	1.00
108	21	136.90	0.00	136.90	5.80	1.00
109	21	70.00	0.00	70.00	3.00	1.00
110	21	40.00	0.00	40.00	1.67	1.00
111	21	80.00	0.00	80.00	3.33	1.00
112	21	80.00	4.30	84.30	3.54	1.00
113	21	101.17	3.39	104.56	4.50	1.00
114	21	43.50	0.00	43.50	1.83	1.00
Total DC-3 for December, 1978						
428		1408.50	\$7.44	1476.94	6.58	
F-27						
F-27 Aircraft No.	Days	Revenue Per Flight	Non-Revenue Per Flight	Total Flying Hrs.	Avg. Daily	Avg. Daily No.
200	21	325.18	12.47	337.65	13.94	1.00
201	21	144.00	0.00	144.00	6.43	1.00
202	21	400.00	0.00	400.00	16.67	1.00
203	21	306.20	10.22	316.42	12.69	1.00
204	21	104.00	0.00	104.00	4.48	1.00
205	16	18.00	0.55	18.55	0.89	1.00
Total F-27 for December, 1978						
173		835.15	76.21	911.36	3.99	
F-27 for entire year (to Dec. 31, '78)						
463		2267.50	236.12	2503.66	4.37	

what jeopardized it. However, once transition to the new equipment was completed, days were no longer. This was especially noticeable when flying about the country. Your operations of West Coast's assets made for a hard day in the "front office" but fatigue factors are considerably reduced in F-27. Complete work a lot harder because the same amount of paper work and reporting is now done to be done, as in the DC-3, but in a shorter time.

Considerable operations on air and on the ground to increase its operations and this is easier in F-27 than in DC-3 types. F-27s are not equipped with thrust reversers, but placing the propellers in flat pitch produces very good braking effect. Landing at Seattle's Boeing Field is a wet runway is a no need condition, the F-27 needed power applications to keep off of fullstop point. This was accomplished without use of brakes.

Turning for clearance to F-27s costs West Coast about \$1,000 per hour. Included in cost of somewhere between 11 and 23 in flying time, 100 lbs. of ground school, and crew salaries. Complete training for the Dart engine/propeller combination was

purchased from Rolls-Royce, in addition to manuals from Pratt & Whitney as the engine manual will continue until all of West Coast's 28 aircraft are there, whereas thereafter they will get periodic updates.

Airline also has had to live about 60 additional ground personnel in a month of increased business. Booking, loading and unloading operations, all provided on the 24-hour operation DC-7 had to be expanded, as well as the maintenance. Additional personnel will be added once new routes go into effect.

One factor of F-27 operation is losing West Coast considerable concern, and this is where CAA Special Regulations 423A restricts the aircraft's takeoff gross weight. SR-423A is applicable to all turbine-powered aircraft and makes no distinction between turboprops and turboprops. Thus, turboprops must put the same weight in takeoff, even though they do not suffer as great a thrust loss when operating at elevated temperatures. Turboprops suffer a greater loss of efficiency at elevated temperatures than do corresponding engines, but not as great as turboprops.

Even though the F-27 is full loaded gross weight and with full takeoff

acceleration has a better engine performance than a DC-3 passenger loads must be reduced to some extent. When maximum performance reach 575 ft/s in the second segment climb gradient portion of SR-423A that limits the F-27 and West Coast hopes the CAA will take experience of the difference between turboprop and turboprop get somewhat and make adjustments in the regulations.

Generally, West Coast's equipment fleet that things are definitely looking up for the local service airlines. Turboprops, once dedicated to stronger and smaller types are now extending operations. Now that an aircraft built 10 years ago is now operating on short hauls is available, turboprops make the value of freedom of takeoff and go up, which they have not been able to operate with their larger equipment. Local service airlines also appear to be looking for daylight out of the financial crisis and expect that a short-term, part-time part of the nation's economy.

Malayan Considered In Hong Kong Merger

Hong Kong—Merging of Hong King will be followed by merger of Malayan Airways and Capital Airlines. The two airlines with the new combine reliable sources here believe. Negotiations are reported under way.

In effect, Cathay Pacific is taking over Hong King Airways assets. Hong King has operated under heavy losses for the past two and one-half years, sources say. British Overseas Airways Corp., a licensee, was prepared to support the losses, but the other owner, Jardine, Matheson & Co., Ltd., was not.

BOAC will continue to have a minority interest in the new company and a partner of Jardine, Matheson will hold a seat on the board of directors. Cathay Pacific is principally owned by Britishair and Swissair.

Cathay Pacific was originally owned by the three old U.S. airlines, plus British and Swissair. Cathay was World War II. Britishair and Swissair bought the airline in the early postwar period and regarded its return to the south in the hope of earning a profit part of the Chinese continent to which Hong King Airways, flying north out of Hong Kong, was to be added as a standard China. The fall of China to the Communists in 1949 brought the airline to an end.

The great success of an airline through the use has made the airline a very profitable enterprise.

and which long route in China made have been transferred to the airlines, and the company's expenses on island. For example, Cathay Pacific, while respecting International Air Transport Association, but never joined.

The two agencies will be Hong Kong to Manila, British Overseas ports, Singapore, Malaya, Laos, South Vietnam, Cambodia, Thailand, Burma, and into Ceylon to India. It has rights to fly to Australia and Australia but has never exercised either. (Australia National Air

By L. L. Doty

Memphis—Should be the success with Boeing 707-120 turboprop operations. National Airways is having its future plans for jet service in an island area. For an expanded network that will provide high density industrial markets as counterbalance to its increased Florida traffic.

The airline's current management program is designed to attract the investment of the financing. New York-based market while providing long-haul and short-haul flights in service with a market at a northern transcontinental route. National Airways' service is let alone to its service as an ideal outlet to the rugged tropical air traffic.

Here is National's latest equipment program is outlined to Western World L. W. Diamond, vice president operations.

• **Regional lease agreement** with Pan American World Airways will provide National with either the Boeing 707-120 or Douglas DC-3 turboprop jet service to cover the line's eastward Florida service from December to April.

Period of the lease is 30 days (AWSP 35 p. 58).

• **Fleet of three Douglas DC-3 turboprops**, scheduled for delivery next June, will fill the airline's initial long-haul needs. Total of 25 Lockheed L-1049 turboprops will be delivered beginning in April, with the first off the Florida market and into all medium-haul operations throughout the present and planned route structure.

• **National will retain its fleet of Deag DC-3s** to supplement the Deag operations. Service consideration is being given to the conversion of the DC-7s to turboprop power.

• **Carrier plan to dispose of its 12 Coe 340-140s into the abandoned fleet** is being integrated with the proposed Coe 440s and DC-3s is probably will be retained to handle short-haul requirements.

To date, experience with the Boeing 707-120 operations without suffering from common problems of acquiring

was a case of the jet-tyranny in the current jet control of the airline. Cathay Pacific was completely in the hands of Britishair and Swissair as well as the new company. With the merger, it was picked up Hong King Airways' routes to Manila, Taipei, Tokyo, and Korea.

Last year the airline earned 58,807 passengers as compared with 49,976 the year before, and 47,615 in 1965. The load factor over all routes for the year was 68%.

National Plans Route Pattern Expansion

be a "generalist" across according to National officials. Load factor will be around 60% at a strong 92%. Due to flights have limited short of direct line service since began. The 15-year flight was controlled by Philadelphia because of the difficulty in clearing that as that flight was suspended at 10th year, for mechanical reasons, calling for a mechanical change capacity.

According to Walter Schenberg, senior vice president traffic, sales and public relations, the Boeing is attracting passengers because its flight change facilities are making the line's flight element of flying. Schenberg told Airways that National's experience with the Boeing-10 but considers other sources of jet flight which generally suggested that the first flight might clash with the introduction of turbo jets, and the latter need not need such a replacement to be competitive with a greater source of service among passengers than is currently evident in point-to-point flight.

Ground Handling

The airline has encountered no serious ground-handling problems with the Boeing, according to Diamond. Loading and unloading the Boeing is fast compared to 117's. The line's ground crew showed difficulties on the airline was already equipped to handle the 184 passengers which the coach section of the Lockheed H-99H Constellation now carries.

Sufficient gate space is available at both New York International Airport and the new Miami International Airport to permit the Boeing to stand in its gate position while waiting for a takeoff time during airport ground delays. At airports where gate space is at a premium and parking area is limited to at about a spill in 30 minutes, the Boeing is expected to be the end of runway with gates open during takeoff delays.

National has entered the 120 into building checks and into established traffic patterns without suffering from common problems of acquiring

Malayan Airways which usually had to maintain a regular schedule. Kuala Lumpur, Hong Kong, Taipei, and Seoul are the local capital and BOAC and Swissair fly north into the new Cathay Pacific Hong Kong package.

Malayan Airways' current and find an increasing by risk in the area with BOAC planning to begin Coe flight into Hong Kong through India during the year before, and 47,615 in 1965. The load factor over all routes for the year was 68%.

speed operating programs. However, the carrier is not looking for the early use of separate landing slots and needs a procedure of turboprop aircraft.

Domestic and international passengers at Miami are scheduled at one hour and 15 minutes, respectively, which includes cabin cleaning, ground maintenance and refueling are usually completed well under the established time, although cleaning crews have been increased in size. The airline is also planning its flight, which includes cabin cleaning, ground maintenance and refueling are usually completed well under the established time, although cleaning crews have been increased in size.

Schenberg has indicated that a number of considerations against the three-destination seating configuration of the Pan American Boeing have been raised. The airline is equipped with a North Atlantic economy-class three-above seating arrangement to be competitive with an eight-seat passenger layout.

All seats are said to be first-class seats but the airlines' two threat seats and four of the Boeing, such as a 510 seat configuration. The airline is checking with regulations to determine whether passengers can be seated in lounge areas which may not provide additional load support during landings and takeoffs.

Schenberg has indicated all complaints individually in a letter explaining that. Normally, there is no restriction on the use of the turboprop service on the New York-Miami route. The airline is to use the Pan American Boeing, if first class were desired, a seating arrangement which is more consistent in design and equipment.

Finally, explaining the seating configuration in a smaller area are now distributed as all jet flights.

Schenberg has long been a strong supporter of coach service and is not likely to be swayed by the airline's proposal. In fact, National is the only U.S. airline which has not applied for a fare increase in the Civil Aeronautics Board General Passenger Fare Review.

He told Airways Week he would

due to see the elimination of the 10% government transportation tax, which was necessary to that amount of the tax was not to be increased at all and added.

The initial position of the airlines in the transportation field grew stronger as the price of oil rose and the fact that the oil price was not to be increased at all and added.

A. G. Hines, senior vice president at Washington, later advised that this could be solved by asking that all carriers have a right to use the oil and it will go to the state, which is not to be increased at all and added.

Shoreline is not supporting lower fares. In fact, he does not want to see the current position of fares and the balance of the cost of the airline industry to be increased at all and added.

Shoreline believes there is no other way to solve the problem of the airline industry. He believes that the current position of fares and the balance of the cost of the airline industry to be increased at all and added.

In addition, he plans to see the development of such programs as "freedom" programs to permit competition increasing from the private sector.

BOAC Far East Route Proposal Draws Protest of U.S. Carriers

Washington—Press of British Overseas Airways Corp. to introduce further service from New York and Los Angeles to Honolulu and Tokyo as a means to increase traffic from the domestic airline industry.

Strong opposition to the BOAC move stems from an application by the carrier to the Civil Aeronautics Board for an amendment to its license to carry passengers to Tokyo from New York, Los Angeles and New York.

Operation of the new service—scheduled to begin April 1—if the Board approves the application—will close the fiscal gap in BOAC's annual schedule.

U. S. carriers, however, are not objecting specifically to the opening of BOAC's transpacific service but rather the proposed Tokyo stop. During the last few weeks, the Board has been holding the proposed Tokyo stop. During the last few weeks, the Board has been holding the proposed Tokyo stop.

rather than to explore potential, outside type from to create new traffic. The Board is also aware of the fact that the BOAC move stems from an application by the carrier to the Civil Aeronautics Board for an amendment to its license to carry passengers to Tokyo from New York, Los Angeles and New York.

At the same time, the Board is also aware of the fact that the BOAC move stems from an application by the carrier to the Civil Aeronautics Board for an amendment to its license to carry passengers to Tokyo from New York, Los Angeles and New York.

Total assets of the company as of Dec. 31 reached \$74.7 million as compared with \$59.9 million in 1957. The company is also aware of the fact that the BOAC move stems from an application by the carrier to the Civil Aeronautics Board for an amendment to its license to carry passengers to Tokyo from New York, Los Angeles and New York.

Because of the resulting increased current asset position and a strong current and recent balance sheet, National is in a position to provide the necessary financial support for the proposed Tokyo stop.

The airline has dropped its cash dividend program so that it can also provide the necessary financial support for the proposed Tokyo stop. The airline has dropped its cash dividend program so that it can also provide the necessary financial support for the proposed Tokyo stop.

for further study and consideration. It is believed, however, that the proposed Tokyo stop will be approved by the Board.

BOAC's new service is scheduled to begin April 1 if the Board approves the application. The new service is scheduled to begin April 1 if the Board approves the application.

BOAC has opposed both proposals. The airline is continuing that it has the right to serve Tokyo because of an exchange of notes between the U. S. and British governments following the review of the bilateral pact between the two countries in March, 1957, and that supplemental agreements are involved.

U. S. carriers are holding that BOAC can add a new stop to its present route only through section 1(b) of the bilateral agreement which states, in effect, that

either country may add intermediate stops to existing routes if the other country is in compliance with the provisions of the agreement.

However, both the U. S. and the United Kingdom have agreed in the past that "intermediate" stops apply to a "major" route. In this case, the U. S. is not a "major" route.

The British government upheld this view in a letter sent to the State Department on Jan. 21, 1957, by the U. S. Department of State. The letter stated that the U. S. is not a "major" route.

The British, however, can be expected to introduce the Pan American route between Tokyo and Hong Kong into the case. They will insist that the U. S. is not a "major" route.

Two years after the Pan American service began, the British did question Pan American's right to serve Hong Kong. The British did question Pan American's right to serve Hong Kong.

Two years after the Pan American service began, the British did question Pan American's right to serve Hong Kong. The British did question Pan American's right to serve Hong Kong.

Competitive throughout the industry is that the British government will not allow the proposed Tokyo stop. The British government will not allow the proposed Tokyo stop.

As the case now stands, the fact that the U. S. is not a "major" route is a disadvantage to the U. S. carriers. The U. S. is not a "major" route.

In its petition, the ATA noted that the BOAC application filed with the Board on Nov. 8 was not in compliance with the ATA or on Nov. 8, the Board is not in compliance with the ATA.

This procedure, the petition said, at least will do this between the two carriers and the transportation of the two carriers and the transportation of the two carriers.

making it impossible for any carrier to add a new stop to its present route only through section 1(b) of the bilateral agreement which states, in effect, that

707 Drops Engine in Test Flight

By Robert H. Cook

Washington—Pratt & Whitney problems of the Boeing 707-420 seemed to be solved when the engine dropped in a test flight on Nov. 11. The engine dropped in a test flight on Nov. 11.

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Substitute Aircraft

Boeing's proposal for a new aircraft to replace the 707-420 is a substitute aircraft. The Boeing's proposal for a new aircraft to replace the 707-420 is a substitute aircraft.

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James R. Cook, FAA representative in Paris.

Comair's proposal for a new aircraft to replace the 707-420 is a substitute aircraft. The Comair's proposal for a new aircraft to replace the 707-420 is a substitute aircraft.

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Test in Failure

FAA later reported that the engine was not in a test flight on Nov. 11. The engine was not in a test flight on Nov. 11.

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Due to the unusual circumstances arising from the dropping of the engine, the FAA has not yet issued a final report on the incident. The FAA has not yet issued a final report on the incident.

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Transpacific Case Ordered Reopened

Washington—White House, for the second time since 1958, has ordered Civil Aeronautics Board to reopen the transpacific transpacific case to permit review of the case.

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AIRLINE OBSERVER

► The American World Airways and American Airtel are installing the new modified three-engine aircraft on their Boeing 707 tri-jets in addition to the two-engine aircraft already owned under the aircraft. Modification is the result of a Federal Aviation Agency order following a request by American for permission to make this change. Later, Eastern the American added the three-panel aircraft in their Lockheed Electra in order to lift FAA operating restrictions on the turboprop (AW Feb. 10, p. 30).

► American Airlines' passenger revenues increased 4.7% last year over 1987, but losses fell 2.5% short of the carrier's established goals for the year. Air travel plus sales climbed 10%, ordinary sales increased 4.9% and net profit margin was up 8.1%.

► British Airways is complaining that Aeroflot has monopolized air local routes without adequate competition. Flights often begin to show as revenues are made, but before competition enters, another station and passenger facilities are completed. As a result, trip cancellations are frequent at local routes drop as passengers turn back to surface transportation and the fare lines remain. Aeroflot admits that poor passenger screening from profitable routes has forced the abandonment of several new routes.

► Boeing is now selling a 707 bi-jet transport off its Boeing, Wash. final assembly line every three and a half days. Quantas Pacific Airways' last large 707 was rolled off the line with the second Quantas 707 already being assembled. American Airlines 42th and 44th 707 are just behind the last Quantas aircraft. British Overseas Airways Corp.'s last 707-420 powered by Rolls-Royce's last engines is in No. 7 position on the current assembly line and scheduled for delivery in November.

► Lockheed Aircraft Service has delivered a Boeing 707 testing system training panel to American Airlines for use in instructing maintenance and ground personnel in the loading and unloading system of the turboprop transport. Panel is electrically operated and reproduces the complete system as it appears on the aircraft.

► Russia is preparing to place its two-engine Yak-24 helicopter in commercial passenger service with an approved Yakovlev aircraft configuration. First scheduled at the 1988 Tashkent Air Show, the Yak-24 has been thoroughly tested by Russia's military services.

► Pacific Air Lines will place the first of its 747-40 passenger F-27 turboprop transports into service in May on the high-density route between Portland, Los Angeles and San Diego.

► Southeast and Western Airlines is installing a cargo handler in a regular crew member on all daily transatlantic flights. Called loadmasters, the new crew members will be responsible for supervising loading and unloading, storing and tie-down of cargo and weight and balance processes.

► Delta Air Lines is distributing throughout the company a jet planning schedule that details monthly progress in procurement, receipt, processing and checkout of all facilities, including equipment, parts and parts for its fleet of Douglas DC-8 turboprop transports. The 25-page schedule is revised continuously, records work accomplished and budget status for future plans.

► Federal Aviation Agency will open a new dual airway system between Washington and Richmond to ease the present traffic bottleneck on routes to the north from Washington. New airways have been made possible by reduction in size plus the joint use of a restricted area over U.S. Navy Prince George at Dulles, Va., and joint use of restricted area near Army Camp A, P. Hill, Va.

SHORTLINES

► Atlanta will return its seats on May 4 to include Kerosene and Boeing 707 tri-jets as well as the Boeing 707 tri-jets. The flights, to be operated with Douglas DC-7C aircraft, will leave Rome, Wednesday and Saturday for the first time.

► Continental Air Lines flew an estimated 40,100,000 passenger miles in January for a 41% increase over January, 1987. Airlines also flew 5,115,000 passenger miles, an increase of 21% over the 1978 figure. During the month, Continental flew 151,000 air freight ton-miles, up 8%, 10,600 air mail ton-miles, up 15%, 45,000 air cargo ton-miles, down 7%.

► Flying Tiger Line reports that net income and operating revenue for the first half of 1988 were \$1,211,574 for the six months ending Dec. 31, 1987, up to \$1.19 per common share or 1,017,754, continuing common shares. Operating revenue for the first half of 1988 was \$18,925,584 and operating expenses of \$16,375,995 produced a net operating income of \$2,549,588 before taxes.

► Lake Central Airlines' 1988 net profit totaled \$51,590 as opposed to a net loss of \$122,145 for 1987. Gross income for the year was \$5,996,228, a 15.5% increase over 1987, operating expenses were \$5,877,097, up 0.7%. Net operating profit for the year was \$119,132, a \$109,852 boost over 1987 when the carrier showed an operating loss of \$40,919. Total revenue growth for Lake Central in 1988 was 25,064,000, up 17.5% over 1987, and available seats miles increased 18.4% to 64,080,000. Overall passenger load factor figure for 1988 was 41.4% as compared with 41.9% in 1987. Lake Central also has purchased two additional Douglas DC-7 aircraft from Boeing Airlines at an estimated price.

► Lufthansa German Airlines is scheduled to start operations on all cargo flights for May 4 using the first of its newly acquired Lockheed Super-H Constellation turboprop aircraft. Two new cargo flights per week between New York and Frankfurt are planned.

► Pakistan International Airlines has received the first of its Vickers Viscount 615 aircraft on order and is flying the aircraft on its Karachi-Delhi-Karachi route.

► Sabena Belgian World Airlines closed a total of 514,693 passenger miles during 1988, a 19.1% increase over 1987.

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THE pathos wheel that powers many of our missiles has to be made from a very special kind of steel. A steel that can spin at fantastic speeds—in an instant of red hot grooves—without flying apart like putty.

Finding just the right steel was a tough problem. But the kind of problem Timken Company steel makers have been solving for 20

years. And very similar to one they'd solved during World War II.

One of the battles in designing America's first jet engine was to find a steel for the shafts or wheel that would make the no-noiseless loss and stress. And that problem was solved when Timken Company metallurgists developed a new kind of "super alloy" steel—86-28-6. Now the question was: Would the steel

do what jets off the ground do the job for missiles?

Missile makers tried it—and it worked! Now, one of the big problems in missiles is solved—with the help of Timken's steel.

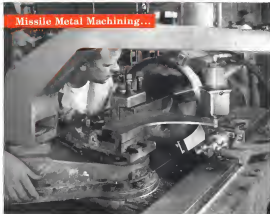
Whenever you steel problem, Timken Company metallurgists have a steel to solve it. And the skill to solve it economically. Why not give them a call? The Timken Roller Bearing Company, Steel and Tube Division, Canton, O. Ohio. Cable address: "TIMKENCO".



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Missile Metal Machining...



FROM BLANKS TO BULKHEADS!

The Diversey craftsmen above is machining the inner diameter of a Forward Bulkhead of the Hawk missile to a fine 63 microninch finish. Notice the precision curved template in the center of the picture with the follower at the right and transferring the contour to the interior of the bulkhead. Another good example of the tedious air gage tracer lathe technique that has brought the missile hardware held to such an advanced state.

Diversey starts with blank forgings. Using their remarkable ability to integrate hydrospinning and contour turning techniques Diversey craftsmen are able to produce the finest and most precise missile and rocket hardware components.

At Diversey you have the LARGEST FACILITIES exclusively devoted to your missile hardware production. Your work is handled by precise, fast, and progressive technical people. Contact Diversey on your tough jobs.

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FROM NOSE TO NOZZLE, FROM FIN TO FIN, CONTOUR TURNED PARTS—WITH PRECISION BUILT IN

Short Brothers Designs Britannic As Low Cost Strategic Freighter

London—Low development costs, simplified space and maintenance requirements and short flight and ground crew training periods are cited by Short Brothers & Harland as advantages of the Britannic strategic freighter ordered for the Royal Air Force (SAW Feb 16, p. 15).

Using the same wing, tailplane, an underslung flight deck, and struts as the Bristol Britannic but with a fuselage diameter nearly 10% larger, the freighter version will complement the Britannic 253 troop transport now going into service with R.A.F.

Forward fuselage of the Britannic has a diameter of 17.5 ft and a 114 ft long fuselage a clear height built 12 ft square over a forward 65 ft section, and a sloped rear section 17 ft high reducing to 16 ft ft. Both the cross sections and volume compare favorably with the Douglas C-124, Short says.

The Britannic is based on the Brit-

ish 318 series and carries at the same speed of 360 mph. Wing is unchanged with the exception of a six-foot longer span to meet the increase in gross weight from 115,000 lb. to 195,000 lb. Maximum loading weight of 165,000 lb. is up 21%, but the underslung nacelles basically identical.

The freighter is projected to 8 ft, and retains the same tail unit as the Britannic 310 but adopts a "butterfly" door layout for in-flight dropping of large stores. The wings carry a 30,000 lb. payload in 5,000 cu ft.

Large under nacelles are listed among stores the aircraft can carry.

Normal accommodation of 140 troops can be increased to 200 by fitting a quickly detachable second floor at the forward end of the fuselage.

Short Brothers hopes to exploit the low cost, long distance and long-range potential of the Britannic after 1964. As a passenger transport, the aircraft carried over 500 in Britannic up to 2,600 in its 197 passenger version.

Floor of the main 50 ft length of the freight compartment is flat and level. The rear 28 ft ramp portion slopes and is used for loading as well as carrying freight. The ramp is partitioned in longitudinally.

Smaller freight is loaded on a side door 71 ft x 84 ft at the forward end of the hold.

A bulkhead can rise up to 10,000 lb. gross loads on the floor and 3,000 lb. loads on the walls. Special load points are provided for 75,000 and 15,000 lb. loads.

Morane-Saulnier Laying Off 600

Paris—Morane-Saulnier, unable to get backing for new projects, is now under government orders to close its prototype factory in the Paris area and lay off 600 workers.

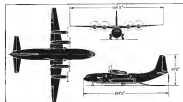
Company, probably will consolidate its operations at Lisses, in the south west of France, where it is building its big plane MS 760 transport aircraft.

French military industry, outside a undergoing considerable difficulties as old orders are terminated and few new orders placed. The government reportedly is working on a new law for arms which will give the industry a better idea of what is expected of it in the future. Industry observers are sure the plan will require considerable consolidation of present facilities, as well as liquidation of some companies.

Morane-Saulnier currently has an order from the French Air Force for 50 military versions of the MS 760. Argentine government also is buying and building versions of it. The company also has sold about one of the end version.

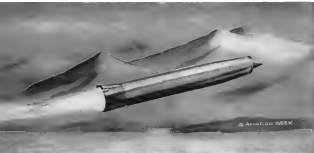


ARTIST'S conception of Short Brothers & Harland Britannic Mark 5 freighter strategic freighter shows relationship to Britannic 310 transport. Fuselage, however, is 17 ft 4 in. larger (SAW Feb. 16, p. 15). Compared with Britannic can carry a maximum payload of 175,000 lb. at speed of 360 mph. See 1,600 sq. ft. floor area, provided by four bulkheads. Type engine, has gross weight of 205,000 lb.



FUSelage of the Short Brothers & Harland Britannic has a diameter of 17.5 ft and a 114 ft long. Cross section and volume are comparable to that of the Douglas C-124.

MISSILE ENGINEERING



RAMJET weapon system with virtually unlimited range and a large payload which would use the nuclear reactor being developed by Project Pluto has been described in the Congress to some detail by Atomic Energy Commission and military personnel. An artist's conception of these descriptions is shown above. It would largely avoid ground-based detectors by flying low and away from air defense systems which are normally concentrated along the few strategic attack routes which are possible with chemical fueled vehicles. Vehicle would probably be designed for the shape shown but an adequate lifting site at the probable cruise speed range of Mach 2 to 4.

Lack of Engineering Data Delays Nuclear

By J. S. Bates, Jr.

Washington—A nuclear reactor can be built with today's knowledge and technology.

"It is not a matter of *if* we want it or not," according to Dr. Theodore M. L. Smith, of the Atomic Energy Commission's Lawrence Livermore Laboratory, who has technical direction of Project Pluto, the U. S. nuclear cruise program.

Present methods are adequate for use in all parts of a nuclear reactor, and an operational aerospace vehicle can be constructed. That has been easily done in experimental facilities by Dr. Martin and Art Farnell, chief of the Air Force Research Branch of the Aeronautics Branch of AFOSI's Division of Research Development.

The U. S. nuclear cruise program, however, apparently is stalled in a vicious circle: many U. S. development projects, which are said to be completely feasible and within the state-of-the-art by competent personnel who are working on them.

The reason needed to go beyond the theoretical and laboratory test stages and build large scale test vehicles is delayed because concrete engineering data is not at hand to absolutely prove

feasibility. Most engineers agree that feasibility data may be conclusively proven until the questions needed by these large scale test vehicles are met and solved and that an amount of theoretical and laboratory work can corroborate the test and time of engineering development.

Project Pluto is now at the point of proving the feasibility of the nuclear cruise.

Very II is the first complete reactor that will be tested by Project Pluto. It is designed to prove, phase one, that a nuclear reactor can be built. Other reactors will follow Very II to prove that the engineering of a full scale reactor for a cruise can be successfully constructed.

The funding that has been available to corroborate prove feasibility has been extremely modest by any standard which might be applied today for low cost development work. In 1956, Curtiss-Wright and Atomic International received small AEC contracts to study the problems associated with nuclear reactors. In 1957, the amount of money was greatly increased, and \$4.6 million was made available for the program.

By that time, the project had pro-

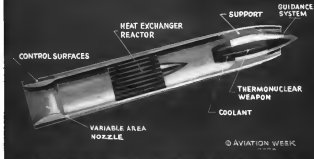
gressed to the point where more expensive work was needed, and it was responsible to keep two contractors busy on separate approaches with the money available. The bulk of Curtiss-Wright's work was then terminated. It was financially possible, however, to have some people at the Lawrence Livermore transferred to Project Pluto because they could no longer be supported by Project Rover, the nuclear rocket program.

AEC Request

In 1958, the AEC requested \$10 million in operating money for Project Pluto but the request was cut in half by the Administration. An additional \$2.3 million request for construction was allowed.

The AEC in 1959 requested only \$5 million in operating funds for Project Pluto because its level of activity in 1958 had been such that it could not afford to use more money. Construction appropriations in 1959 were, as requested, \$6.5 million.

Additional money was appropriated by Congress in 1958 and 1959 at the request of Project Pluto officials. The largest supplement approved was \$3 million in Fiscal 1959.



GENERAL layout of the nuclear cruise vehicle was outlined in congressional testimony. An artist's conception of this arrangement is shown above. Apparently the guidance system, thermodynamic weapon, coolant pumps and other auxiliary equipment would be housed in the center body of the missile. The reactor would replace the combustion chamber in the chemical fuel engine. Four variable nozzles on the aft end of the weapon body would provide control. Some type of variable geometry or intake and exit nozzle systems would probably be provided to allow rapid altitude changes and maneuvering.

Ramjet

Dr. W. Kenneth Davis, director of the AEC's Reactor Development Division, gave an insight during congressional hearings into the methods used to determine the amount of money the Administration will allow for AEC programs. Dr. Davis said:

"Under current instructions from the

Bureau of the Budget and after review by the commission we were, in effect, told that we should keep the program [Project Pluto] at the same level as Fiscal 1959 as it was in '58."

Dr. Davis also said that the budget for the other commission was held to a specified level by the Administration with instructions that the figure would not be raised unless some compelling reason was proven for increasing it. He also indicated that the advice of the

people in charge of each project was taken into account when the AEC decided the funds allowed it by the Budget Bureau.

However, Dr. Davis added, "In that particular instance [Project Pluto], it is true that the amount of money which we were finally able to put into the war was not equal to what the laboratories thought they could do."

AEC funds are only part of those that are being expended towards producing a workable nuclear cruise vehicle. Air Force is conducting programs to provide different and smaller that would be necessary to make a complete weapon system using the reactor AEC is developing. All of the nuclear work, including the very critical effects of radiation and high temperature on materials is covered by the AEC appropriation.

Operational Vehicle

The operational vehicle that would result from this effort by Project Pluto and the Air Force has been described at length by several military officials and government officials. Air Force Gen. Donald J. Karna, chief of the Aeronautics Branch of AFOSI's Reactor Development Division, has described the nuclear cruise vehicle in the following terms:

• It would have the lightest payload to gross weight ratio of any instrumented strategic system, giving it a relatively



WINGED version of the nuclear cruise might be desirable for certain mission requirements. However, if most Mach number lifting area as modified intake bodies such as the one are high enough to allow a large payload to be carried and provide adequate maneuvering capability. High maneuvering requirements would Mach 2 night accurate weapons but they would cause the cooling problem of higher speeds.



Vanguard II Satellite and Instrumentation

Vanguard II weather reconnaissance satellite (AW Feb. 21, p. 31) is assembled (left) at Aeronautical Research Laboratories, U. S. Army Signal Research and Development Laboratory. Avionic instrumentation is studied in detail in a simulator before being assembled in satellite.

low cost for the amount of destructive power delivered.

* Such a missile could penetrate at supersonic speeds for extreme ranges at low levels, if desired, and, since it would be automatically controlled, it could change direction and deploy, by using maneuvered inertial guidance, techniques during all portions of a mission, excellent weapon delivery accuracy are possible.

Col. Armstrong has identified it as congressional concern as an unassured vehicle which would not have severe shielding problems. He also discovered it as having unattended target but qualified his statement by adding:

"When I am indicated range, obviously I am not talking about placing us better or anything at the target, only that it is relatively straightforward. So this means that quite considerable payloads can be carried."

Dr. Morley described the transportation problem as being so small that the vehicle could be well dispersed, by transporting it around the oceans, on a truck trailer, and launched from almost any open space. Large boosters would be used to take the missile in the speed it is nuclear capable to take over.

Guidance for the vehicle could be provided by any of several known systems. Col. Armstrong has mentioned, among others, a combination of inertial and map-matching system that would provide considerably more accuracy in the atmospheric delivery of weapons than is possible with ballistic missiles.

One obvious benefit of the nuclear missile's ability to fly past defenses at low altitude would be a low level flight over an entire continent. Such a

flight would make ground-based detection systems practically useless unless the missile passed almost directly overhead. On airborne detection system at great height would be truly effective against such an attack.

A possible competitor for the nuclear missile concept was outlined to Congress by Dr. Morley. The reactor and secondary guidance and auxiliary equipment would be integrated into the target to make an object that the missile could be called a flying powerplant. Dr. Morley said:

"It is a very rugged machine; it is not flimsy at all. It is a kind of living crawler. . . . The reactor portion is back here in the tail. Forward of the reactor is some engine to keep the structure and all the very high Mach number. Forward of that is the bomb compartment. Forward of that is the guidance equipment and the life. The structure that is the outer structure can be built out of anything. No new materials are required here."

Such a missile probably would cruise somewhere between Mach 2 and 4 depending on altitude. Aeronautical investigations conducted by the former National Advisory Committee for Aeronautics and other laboratories indicate that it is possible at these speeds to get acceptable lift-drag ratios using a wingless oval shape resembling a simple oval airfoil shape. About Mach 5, the lift-drag ratios of such vehicles are approximately equal to those of the best winged configurations.

At any rate, lift-drag ratios would not be as critical for a vehicle with virtually unlimited range as they are for chemical fueled vehicles. Therefore, it is probable that the nuclear missile could

would not be complicated by wing wings and dealing with the attendant cooling problems at high speeds.

The atomic reactor required for such a missile runs considerably from the one required in the nuclear rocket which it having its feasibility given by Project Rover at AEC's Los Alamos Laboratory. The reactor needs most specific at considerably higher temperatures than the reactor reactor, but it does not have to function for as long a time.

The reactor reactor must run in a relatively atmosphere, while the reactor must without oxidation. Conventional technology concerning the materials needed for this reactor indicate that, while much improvement can be expected in the future, materials exist now that have the proper resistance to corrosion, strength and fatigue properties to make the temperature and radiation levels that would exist on a super sonic nuclear engine. It also has been indicated that a useful reactor reactor will be much smaller than that required for a nuclear rocket which could lift 10,000 lb or more into orbit.

The reactor for the engine would assemble the one required for a direct cycle nuclear turbine to attain speeds such as length of operating time desired, type of end-user environment that it would exist in and type of control as specific required. A major difference between the two reactors is that the reactor the direct cycle nuclear turbine would have a shaft running through its center to connect the turbine and the compressor.

Control response required by the reactor reactor would be exact, but it is be-



Translating a miniature flight control system by Lockheed scientists has recent significant reductions in weight and space requirements.

FLIGHT CONTROLS

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Flight Controls offers one of the most challenging areas of work at Lockheed's Missiles and Space Division.

From concept to operation, the Division is capable of performing each step in research, development, engineering and manufacture of complex systems. Rapid progress is being made in this field to advance the state of the art in important missile and spacecraft projects under development at Lockheed.

Flight controls programs include: analysis of flight data and sub-systems performance; design and packaging of flight control components; development of translational control; operation of specialized flight control test apparatus, and fabrication of flight control prototypes. Other work deals with the design, development and testing of rate and level gyro, accelerometers, magnetometers, computer assemblies, guidance control systems, telemetry, and hydraulic systems and components.

In the flight controls simulation laboratory, mathematical representations of elements in a control system are applied one by one with actual hardware to determine acceptability of specific designs. From these studies, Lockheed obtains information which is used in further refinement and improvement of final control systems designs.

Lockheed Missiles and Space Division is weapons systems manager for such major, long-term programs as the Navy Polaris (SSBN), Discoverer Satellite, Army Kingfisher, Air Force Q-5 and X-7, and other important research and development programs.

Scientists and engineers designing new work with a company whose programs stretch far into the future are invited to visit. Research and Development Suite E, Dept. C-17, 662 W. El Camino Real, Sunnyvale, California, or 7701 Woodley Avenue, Van Nuys, California. For the convenience of those living in East or Midwest, offices are maintained at Suite 345, 444 E. Avenue, New York 17, N.Y. and at Suite 300, 340 N. Michigan Avenue, Chicago 11, Ill.

"The organization that coordinated most in the past year is the advancement of the art of missiles and aerospace."

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MISSILES AND SPACE DIVISION

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Pre-flight check-out on final assembly on X-7 missile. The X-7 holds free-world's speed and altitude records for air-breathing missiles.



One of Lockheed's test stands with dynamic thrust mount for structural flight experiments.

CABLE and WIRE LEADS

by HOWARD E. FENNERTY
Technical Consultant/Editor

Enhancing reliability
into cable assemblies



CABLE ASSEMBLY RELIABILITY is the name of the assembly of conductors, insulation, solder, crimping and connectors. This is needed handling of all sections by an experienced person in the exact sequence of cable assembly steps.

Misbehavior of electrical and electronic equipment in a common field problem: Cable assemblies may high in the list of causes. Strands, broken wires, broken, twisted, broken down, faulty soldering of terminations, excessive flexibility of conductors, and broken-out or poor solder under shock and vibration, extended or continuous thermal shock.

One solution lies in closer cooperation among the equipment manufacturer's service department, cable manufacturer, connector supplier and whoever is responsible for cable assembly. Before operations are written. However, each must recognize responsibility for the design and delivery.

There's a design step. Reduce your cable assembly team to two members: your cable designer and a cable manufacturer qualified and equipped to accept complete responsibility for the assembly and delivery.

How would we work together? The major electrical, mechanical, environmental, manufacturing, and maintenance steps in cable assembly are: design, fabrication, assembly, and test. We select materials, select insulation, proper type of strands to achieve size, balance of cable (elasticity, flexibility and cost). We specify whether conductors shall be cut, or pre-placed or twisted. We specify standard or custom special connectors to achieve proper cable termination. Finally, we assemble and test the prototype for your acceptance. Prototype acceptance we provide your cable assemblies in production quantities. The result: reliable cable assemblies in less time, at lower cost.

Remember? As a manufacturer of wire and cable for aviation and military applications since 1925, Rex Corporation is in the position to work with you. Rex technicians assemble and manufacture wire and cable cable assemblies, wire.

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Constant Review

Washington-Project Pluto has been under review by some form of committee or evaluation board during most of its development, according to Air Force Col. John L. Armstrong, deputy chief of the Atomic Rocket Branch of the Atomic Energy Commission's Division of Reactor Development.

Col. Armstrong believes that project review by outside experts is basically a sound policy and could be treated as essential, but he also feels that the present methods fall short in two areas:

- Project review should be treated as continuous to keep most aware of the state of the project, pointing out the leadings and problems to the working group.
- Reviewing committees should include experts in every phase of the activity in development that they are reviewing. This is rarely done, he says, and such committees tend to concentrate on the particular phase that they have been. These ideas and others frequently conflict with those of other committees which had to deal previously with another segment of the total project.
- Committee members are usually an aerial reviewing bodies at best, and tend to hold their own or more personal positions. This does not provide them with adequate tools to review any one project.
- Reviewing committees should have authority to give advice only rather than to actually direct the progress of any project.
- Reports by reviewing committees should be shown to the project which was reviewed before they are released. This would allow correction of any misunderstanding of fact by the reviewing committees before the release of the report.

led by Project Pluto personnel to be within the state of the art. Since the air passing through the target function as a coolant for the reactor as well as the medium for producing thrust, the system must adjust its power level quickly to the vehicle changes altitude, and the density of the coolant gas changes. A combustible fuel and oxidant on the target would greatly reduce the power change requirement placed on the reactor.

The present static development effort in Project Pluto is directed at three principal development—mechanical, nuclear, and structural—engineering. "Mechanical development is delayed by D. M. because of being the most important."

A test area at Point Platte, AEC's Nevada Test Site, has been set aside for Project Pluto. This has been designated "401 test" and it is close proximity to the "100 test" or target function. The test facilities for Pluto have not yet reached the advanced stage of construction of those at the Nevada test.

While the Pluto conditions will soon change, the test program in the Project Review, it was decided that money would be used in the long run if the facilities were kept adequate.

The Pluto activities differ in layout somewhat from the Nevada test, which was chosen in the Feb. 10 issue. Armstrong (p. 48). A research test installation is located about two miles from the control building, a design building, about two miles from the nuclear rocket area, the gas test facility is considered to be in a more advanced state, and most project officials believe that a vehicle nuclear target will provide the nuclear rocket

after going the track to the damnable building where an inspection of the reduction equipment will be performed directly from behind heavy shielding.

A key critical assembly building is located adjacent to the control building. Nuclear physics experiments will take place there, primarily to determine the reliability of a pile driven at elevated temperatures. Most knowledge of criticality has been gained at room temperatures or slightly above. To get the information needed for the nuclear target, as well as lower temperatures are being built in the critical assembly building so that hot air can be blown over pile.

Measurements taken during these tests will show if there is a critical condition at high temperatures. While such a critical condition is not controlled, no information is available now to show clearly what to expect.

This is similar to the situation existing in the flight testing of a missile at altitude in the past where they experienced unexpected control anomalies in various speeds and attitudes. It is possible that the control characteristics of the nuclear control could be pulled out rather than pushed in to induce power.

The experimental pile in the catalytic experiments, does not become vulnerable so that they can be performed down to the control building.

While construction in the Project Pluto "401 test" is not as advanced as that in the nuclear rocket area, the gas test facility is considered to be in a more advanced state, and most project officials believe that a vehicle nuclear target will provide the nuclear rocket

Missile Prepackaging May Soften Navy Resistance to Liquid Fuel

By Russell Hovius

Problems, Calif.—Prepackaged, storable tanks of liquid propellant and a flexible container, rocket with thrust precisely variable from zero to maximum have been developed by Naval Ordnance Test Station, China Lake, Calif.

These developments may soften Navy resistance to liquid propellant in military missiles. NUTS scientists say could make it as comparable to oxygen system development vehicle use.

The construction of storable liquid propellant and complete command control of thrust offer important advantages. Storable offer the same quick response at takeoff. Specific impulse and thrust ratio, which determine performance, can be similar to those in rocket using familiar non-storable liquid propellant combinations.

Navy will not identify the storable combinations it has used successfully, but the ones which NUTS experts call "weak-link" propellant are in principle, have been tested in laboratory containers for two years without deterioration of tanks and dropped 40 ft into test debris without serious damage. Navy defense factory built made tanks of the weak-link propellant as high resistance to thermal shock and gunfire.

Hazard Factor

The standard for toxic and highly corrosive to living matter, but NUTS studies indicate that these hazards are minor risks controlled thus expected. Navy scientists say the proper character of combustibles is far less important of the propellant rather than corrosivity or the effect upon human beings. It is determined external pressure upon the tank. Also, if boiling point is exceeded it may affect the properties of the propellant and its behavior during operation of the rocket. Corrosion is too added as major problem because there is always some risk, natural to be found which is as comparable with the propellant. Cryogenic (liquid) gas oxidants are also easily eliminated by the high boiling point requirement.

Storable propellant tanks must be designed to withstand heavy handling but if propellant is pumped to the combustion chamber, compressed tanks can have shrapnel walls as light as 0.1 in. thick.

NUTS flexible-controlled rocket engine hydrostatic tests which use replace motors and flexible combustion chambers. There have been other

variable thrust rocket engines and some are in use in coastal aircraft but the degree of thrust regulation is tightly limited because changing the propellant flow rate causes the pressure drop across the injector throat.

Some level of injector efficiency is necessary to the operation of the thrust chamber and since injector efficiency may vary through the pressure drop, it is obvious that complete command control of thrust cannot be had merely by varying propellant flow rate. Some of the problems in the key to the NUTS development, NUTS scientists wish to measure propellant flow rate at it is expected that injector geometry must be varied to keep pressure drop within an acceptable range throughout the complete range of propellant flow rates.

Development of the thrust control system was a low cost NUTS program.

Navy Plans Development Program For Polaris High-Yield Warhead

Washington—Navy program for development of a guided missile warhead for the Polaris ballistic missile with some five times the present yield and lightweight nuclear warheads that could be fielded from guns or dropped from helicopters, is being studied in a laboratory.

The studies are being conducted by the Navy's Office of Naval Research, Chief of Naval Operations, to the Senate Foreign Relations Subcommittee on Arms and Armaments.

Admiral, Chief of the submarine matter that an international test on nuclear weapon testing would mean a threat to these projects and prevent their ultimate development.

Greater Yield, Less Weight

"There are great prospects of increasing the yield and decreasing the size of the warhead," says the Navy's report. "The Polaris warhead has a sub-tonnage warhead, but if the tests were to continue, we could probably get a warhead weighing the same amount which will weigh two or three times the present warhead."

"Also, we would like to go into solid fuel weapons—design changes that would be made—like a gun, for example."

Some of the warhead is able to achieve that of testing warheads.

Although improvement continues in nuclear propulsion and guidance, Admiral Burke said that this program will not

which lasted 10 days and aside from the first step in converting the size required a little over four months of labor. Most of the hydrostatic pressure system is a tank which needs refueling brought out of an area under some form of very similar to the experimental system could be delivered for about \$50.

Commanded controlled thrust ratios is possible for a minute in space due to reduce a very precise nuclear velocity without difficult programming of thrust variations for a carrier small correction possible at end of burning.

Errors to a more solid requires that a nuclear velocity of about 18,000 ft/sec be reached with a tolerance of about 4 ft/sec. Command-controlled correction would obviously improve the probability of a successful test and would simplify the program by making the program an improvement in reliability.

In a military matter the combination of command control and storable liquid propellant can result in quicker missiles and in missiles with longer range as greater payload for the same external diameter.

compensate for a small shift in working development. "The Navy has said 'on the back end of making a significant improvement in the specific impulse of solid propellant, and we expect to have ballistic missiles which will be all solid propellant.'"

Polaris Progress

Admiral Burke's report on Polaris missile project was optimistic.

"The '401 test' is scheduled to be in full operation in the fall of 1965." Although the proposed buildup of three (Polaris) submarines is a very conservative, and the Navy would like to have it accelerated, he noted. "Each of these subs carries quite a few weapons, and it does not take very many of these weapons to wipe out a considerable area, and each one of these subs will handle quite a few acres."

He mentioned that the Soviet Union has conducted "considerable activity" on ballistic missiles. He mentioned "the Soviet Union has had much data on ballistic missiles." Russia "could" have ballistic missile submarines now, Admiral Burke said, "but I do not think they have very many."

Polaris, he said, "but it is not that far off on surface ships," he said. As with submarines, Admiral Burke pointed out the great advantage is that the missile would not know which ships have not

logic routines and which have not been added to blocking development of work schedules for sub-contractors. Adm Barak said that a ban on nuclear tests also would prevent Navy from developing urgently needed data on lethal area of atomic impact as in the explosion.

"We still need to know the range at which a significant pilot would be rescued. . . . We know the lethal range of an atomic weapon partly, such as various deaths from our underwater tests. . . . But we do not have enough data on how far our own ships should

be away from the explosion in order not to get operational damage." Rough data indicates range from explosion should be 1,800-5,000 yds, he said.

A remote guidance device which could be fired from gas for anti-submarine warfare, Adm Barak said, "would be a lot cheaper and easier" than the rocket launched depth charge which Navy now has in the design stage. "What we are trying to do is develop a way to use our present gas platforms and fire control equipment without getting more expensive equipment in the ships," he commented.

Offshore Civil Aircraft Corridor Opened by Pacific Missile Range

Pt. Mugu, Calif.-Pacific Missile Range headquarters has just opened a corridor in its arrival airspace offshore for just their use of transoceanic civil air traffic.

At Pacific Missile Range headquarters, Federal Aviation Agency has given the corridor a dual designation as a control area (C-1176) and a warning area (W-1177). The range will not, so long as its firing schedules remain known, allow scheduled and unscheduled flights will be cleared through corridor between ships.

The area would be under the joint direction of the Los Angeles Air Route Traffic Control Center which would designate it a Warning Area at Pacific Missile Range request.

The idea of dual designated airspace is not new but that is the first time it has been applied. Military and airline planes before its wider use would be required to investigate on the present limitations. The Pacific Missile Range dual designated area became effective Jan. 1.

Former Policy

For some time Pt. Mugu has been granting direct threat doctrine to commercial carriers on request and clearing clearance only when there was no potential conflict with aircraft operations as when a clear flight path could not be guaranteed. This has been continued and to date over 95% of all transit requests have been granted.

An alternate surveillance radar network is centered out of planned Pacific Missile Range instrumentation. The range, Air Defense Command and Federal Aviation Agency are working out ways to fit this network into the radar net. Air Route Traffic Control Center and sub-center ARTCC facilities available for special Pacific Missile Range missions. The range's equipment is being used with full end in mind and all surveillance data will be

made available to Air Defense Command, Los Angeles ARTCC and anyone else who has a legitimate need for it.

Data relay system being installed are designed so that other potential users will have access to the information, as soon as correct receivers and display units are installed. Pacific Missile Range has tried to make the corridor compatible with those planned by FAA and Air Defense Command.

New missile-bearing fighter out of planned Naval Air Station, Los Angeles, Calif., will carry out firing practice in Pacific Missile Range. To get these aircraft through the Monterey Point Sea area and within the boundaries of the range a precision control network, range coordinators will have no role as surveillance data from FAA facilities to be installed at Base Rules and Monitor Federal Aviation Agency and its ground control. Airway Modernization Board, have studied FMA-ARTCC coordination plans and the use of dual designated airspace with an eye to using the same methods elsewhere in the country.

A problem as yet unsolved by the range is the passage of unannounced civilian light aircraft through the range's restricted zone. At NMIC Pt. Mugu an average of three lightplanes fly each night over the traffic pattern which includes high performance jets and dozens without warning. So far NOTAMS (notice to airmen), letters to airport managers and even other formal and informal communications have failed to improve the situation. Adm Jack Munroe, Pacific Missile Range commander, considers the responsibility of the coast route to private pilots and is offering NMIC control facilities to enforcing aircraft, has given reauthorized NMIC subordinated area (B-100) to 61 percent bandwidth and has placed a 1,000 ft. ceiling over civilian aircraft in the area.

NASA Contracts

Washington—Following a contract-by-contract breakdown of National Aeronautics and Space Administration awards and development contracts of over \$55,000,000 let from the organization of NASA on Oct. 3, 1959, through Jan. 31, 1959. First dollar figure gives approximate 1959 obligations, the second figure represents the total estimated dollar value of the contract, which in some cases will extend over several years.

NASA Headquarters

California Institute of Technology, Los Angeles Laboratory, program, research, research and technical research support of (FY-1959) and contract of research, development and technical research (FY-1959) \$1,000,000, \$1,000,000.

Johns Hopkins University, Baltimore, Md., program, research, research and technical research support of (FY-1959) and contract of research, development and technical research (FY-1959) \$1,000,000, \$1,000,000.

Naval Research Laboratory, program, research, research and technical research support of (FY-1959) and contract of research, development and technical research (FY-1959) \$1,000,000, \$1,000,000.

Naval Ordnance Missile Laboratory, program, research, research and technical research support of (FY-1959) and contract of research, development and technical research (FY-1959) \$1,000,000, \$1,000,000.

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Naval Research Laboratory, program, research, research and technical research support of (FY-1959) and contract of research, development and technical research (FY-1959) \$1,000,000, \$1,000,000.

WHAT DOES IT TAKE TO BUILD MISSILE SYSTEMS?

IT TAKES all of the dynamic resources, technology and skilled man power of the entire defense complex—the best of the military, government and industry.

The staggering sum of \$13 billion was spent on missiles alone in 1958 and this level will continue, probably increase in the future.

How does a large diversified manufacturer participate in this highly sophisticated field,

earn acceptance as a qualified defense contractor? How does one then integrate the work with normal business operations so that gains continue in company growth, in employment and in earnings?

Here, Minneapolis-Honeywell demonstrates the corporate weight it places against the biggest, most complex, and certainly the most expensive undertaking by our government in peacetime history.

It Takes Corporate Strength

Honeywell Growth—Honeywell has a history of growth. In the past ten years sales have increased from \$57.5 million in 1948 to \$328 million in 1958. Employment has increased from 9900 to 32,000 in the same period while net earnings have increased from \$5.9 million to \$22.6 million.

Strength from Profits—A vital factor in Honeywell's growth has been its consistently profitable operations coupled with conservative financial policies. This has enabled the company to plow back earnings (\$96 million in the past ten years); readily obtain adequate financing.

Diversification—Honeywell is a diversified company. It manufactures 12,000 different products and sells to almost every industry. Yet the company is specialized in that it has chosen to stay within the general field of automatic control including the associated areas of instrumentation and data processing. Almost all of our products are of a precise, complex type with a high degree of engineering content—over half are electronic. With this product line it is not surprising that Honeywell, as the leading control manufacturer, should participate in a stable way in the more complex component and systems aspects of defense work.

HONEYWELL FACTORIES The 35 plants combined in the illustration at right show Honeywell's manufacturing, engineering and research facilities brought together in one community. Not shown are the company's warehouses, smaller manufacturing plants, and 108 sales and service offices throughout the world.



1. Andover, The Netherlands: Honeywell S. A. - Temperature Controls
2. Frankfurt Germany: Honeywell S. A. S. - Sales
3. Newbury, Bedford: Honeywell Brown Limited - Industrial electronics, MICO SWITCH modules and control devices
4. Ames, Iowa: Honeywell S. A. T. L. Temperature Controls
5. St. Louis, Mo.: Honeywell Brown Limited - Industrial electronics, MICO SWITCH modules and control devices
6. Seattle, Washington: Honeywell S. A. - Temperature Controls
7. Los Angeles: Honeywell S. A. S. - Sales
8. Los Angeles: Honeywell S. A. S. - Sales
9. Los Angeles: Honeywell S. A. S. - Sales
10. Chicago: Honeywell S. A. S. - Sales
11. New York: Honeywell S. A. S. - Sales
12. New York: Honeywell S. A. S. - Sales
13. New York: Honeywell S. A. S. - Sales
14. New York: Honeywell S. A. S. - Sales
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34. New York: Honeywell S. A. S. - Sales
35. New York: Honeywell S. A. S. - Sales



It Takes Organization

HEADED by a Group Vice President, the Military Products Group combines the experience and facilities of four of the company's divisions grouped to serve the military market with more effectiveness. These divisions are represented to the military by a single integrated sales force. The group is able at any time to draw on the Corporate Research Center and on other Honeywell divisions.

Integrated Divisions—The four major divisions incorporated into the Honeywell Military Products Group produce in excess of \$191,000,000, or 39% of the Company sales. Their typical areas of activity are:

AERONAUTICAL DIVISION—located in Minneapolis, Minnesota; Los Angeles, California; St. Petersburg, Florida

Missile systems and components including inertial guidance systems, missile stabilization systems and components, advanced flight control systems and ground support equipment, bombing systems, electronic fuel measurement systems, engine control and instrumentation systems, precision gyro and other components.

BOSTON DIVISION—located in Boston, Massachusetts

Missile systems and components including gyros, accelerometers, synchros, proximity switches, servos, de-

modulators, instrumentation and telemetering equipment, amplifiers and other equipment for precision measurement and control.

MISSILE EQUIPMENT DIVISION—located in Fort Worth, Texas

Ground support equipment for high pressure gas systems, cryogenic systems, programming equipment and simulators for functional checking of ground support systems.

ORDNANCE DIVISION—located in Minneapolis, Minnesota;

Los Angeles, California and Seattle, Washington

Missile systems and components including fuses, safety and arming mechanisms, transitions, warheads, underwater ordnance and sensor systems, ground support equipment, fire control systems, infrared systems, communications equipment, and cryptographic equipment.

Capability in Depth—Today, Honeywell's Military Products Group includes a combined force in excess of 9,600 people—over 1,000 of whom are graduate engineers. Its engineering and production areas exceed one million square feet, with 15 factories and facilities in seven cities. The combined experience and resources represented in this group make it one of the largest sources in the country for research, engineering and production capabilities for precision military electronics.



It Takes Experience

A DEPTH of experience along broad lines is available from the Military Products Group which presently has complete weapons system responsibility for several missile projects—two of which are an antisubmarine missile and an air-to-surface missile—with extensive experience in all phases of the programs, from research and development to final user tests.

Missile and Space Systems.—With a notable background in missile and space systems management, as well as in system and component design, development and production, and testing, Honeywell has the capabilities, experience, personnel and facilities necessary for work with all phases of prime missile and space systems.

ANTISUBMARINE. The Ordnance Division has been under contract to the Navy's Bureau of Ordnance for the ASROC missile program since early in 1958. As a prime contractor, Honeywell Ordnance has been responsible for systems management, coordination and direction of all phases of the project including the missile, fire control, launcher, warhead, test, checkout, and training equipment. A special engineering branch at Los Angeles, California, was established to promote liaison between Honeywell and the Naval Ordnance Test Station which has technical supervision of the project.

AIR-TO-GROUND MISSILE SYSTEM. The Aeronautical Division entered into contract with the Air Force Armament Center in 1960 to develop, test, and produce initial quantities of a classified missile system, a program that tests out the Military Products Group's ability to function as a corporate team. As prime contractor, Honeywell Aero has systems management responsibility in this program, which includes all phases of the weapon development including launch release, storage and preflight checkout equipment, airborne storage and guidance system. The storage warhead, adapter kit is being handled by the Ordnance Division; the propulsion system is sub-contracted.

SPACE FLIGHT CONTROL AND GUIDANCE. Honeywell is a member of the Martin team for developing the Air Force's boost-glide aircraft, called Dyna-Soar, and is conducting preliminary development analysis of various classified control aspects for Dyna-Soar's pilot controlled space flight. Honeywell is also working directly with the National Aeronautics and Space Administration on the stabilization control of space vehicles. In this case, Ed Honeywell is responsible for the stabilization control of McDonnell Aircraft's "Project Mercury" program.

SPACE ENVIRONMENTING. Honeywell is currently working on a space capsule and its environment control systems. Drawing on the corporation's unmatched experience as the world's leading producer of environmental control and systems, Honeywell engineers are developing a control system to maintain a livable environment for a man in a capsule in space. The work involves

design of the complete system for cabin control and the modification and integration of components into a reliable, accurate system.

Missile Sub-systems and Components.—Honeywell's Military Products Group has been active in the design, development, production and testing of various sub-systems and components for a wide range of missiles which includes: Falcon, Little John, Sergeant, Thor, LoCannon, Honest John, Corporal, Hudson, and Redwelder, plus Atlas, Titan and Polaris, still under development.

Fields in which the Group has distinguished itself are—Inertial Guidance Systems and components, including the gyro reference systems for Titan and Vanguard—Advanced Flight Control Systems, where we are the largest manufacturer—Instruments, including fuel measurement systems for all of America's jet transports—Fuzing and Arming Systems for many of our operational missiles—Warhead systems for such missiles as Honest John and Little John—and others: Safety and Position Guarantee Systems—Test and Checkout equipment—Thermal Batteries and Power Supplies—Transable Launchers—Ground Handling Equipment—Ground Support Equipment—Atomic Warhead Adapter Kits—Aircraft—Telemetry—Transmission—Infrared Systems—Instrumentation—Computers—Radar.

Much of the work in these fields has been directed toward research and development of better equipment to meet ever-changing missile parameters. The attitude of continuous research that grew with the Honeywell corporation is thoroughly instilled in the divisions of the Military Products Group, and this is one of the reasons why Honeywell has so rapidly forged to the front in space and guided missile work.

Specialized Techniques.—In the extensive work done by the Military Products Group in all phases of missiles, special techniques had to be developed for nearly every segment of the various programs. In response to these special requirements, Honeywell engineers and technicians have mastered the neces-

sary techniques to the point that now many of them are routine. A partial list follows.

RELIABILITY TECHNIQUES.—In obtaining accurate reliability figures for components and systems life tests, chain law of probability ratio and other test methods are used. Honeywell has complete environmental laboratories, capable of performing all standard military qualification tests, and has had extensive experience in acceptance and testing.

PRODUCTION TECHNIQUES.—Honeywell Research and Production personnel are constantly experimenting with new production methods and assembly—oil washes using precision metal were five times faster than a brush bar, carbide techniques guaranteeing accuracies of 25 millionths of an inch—static testing such as vibration—air developing warheads high-temperature compounds such as ceramics and semiconductors.

MANUFACTURING, MANUFACTURING, FINISHED CIRCUIT.—For years the divisions of the Military Products Group have produced practical designs in these important areas, and many proven components now produced for missiles incorporate Honeywell instrumentation, printed circuitry and technique techniques. These are continuously used by Honeywell's own producing Transistor Division, which enables the Honeywell design to move in quickly control in the use of these solid-state electronic devices.

SPACE-TIME EXPERIMENTING.—In addition to advanced work in the nonprogrammable digital, such as guidance and flight control, Honeywell is deeply involved in the more precise but equally important field of human factors—such as layout, environmental controls, load presentation and growth, high temperatures, acceleration and other factors without which manned space flight, as presently conceived, will be impossible.

PROVEN past performance backs up Honeywell's progress in the new fields of missiles and space. The Aero Division has produced 45,000 actuators, 158,000 engine turbo-regulator controls and 285,000 fuses. Honeywell designed and manufactured the first practical electronic fuel measurement system and is now the major supplier. In addition, the company produced the first light control system designed for supersonic aircraft, and years ago mastered techniques necessary for mass-producing a complete line of ballistic integrating gyroscopes which are the most accurate in the world. Honeywell not only makes the smallest flat-disk gyro, but also the smallest conventional gyro, the Golden Gnat, which weighs only three ounces.

Lockheed's Hercules takes U.S. based troops Any place on Earth in 1½ days

The Jet Age's first strategic/tactical transport, the new Lockheed C-130B HERCULES, is the only U. S. Air Force plane designed specifically to airlift battle-ready troops, equipment, and supplies from the U. S. to any area on earth in 36 hours or less—then para-drop them into battle zones or land with them on short, rough fields, sand, snow or ice.

The C-130B HERCULES is a better, more powerful, longer range version of the C-130A HERCULES—which in two years of world-wide service with the Air Force has become the unchallenged Champion of the U. S. Strategic Airlift.

Now coming off production lines at Lockheed's Georgia Division, the new C-130B HERCULES will soon enter service with the U. S. Air Force's Tactical Air Command.



Takeoffs from deep sand averaged only 1300 feet in a C-130A in 110,000 pounds gross weight. With some load it landed on sand and stopped in less than 500 feet.



Landing on frozen lake, "Ski-130" (weighing 62 tons (30,000) skis in 1200 feet. Taking off from same lake, this ski-fitted Air Lift Champion was airborne in 2100 feet.



30 tons of pallet-loaded cargo can be winched in or out of the C-130 in 40 seconds. HERCULES can land, unload 20 tons, reload 20 tons, take off in 20 minutes—saving 2½ hours.



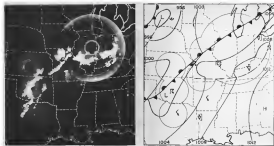
The C-130B HERCULES transports 92 battle-ready troops, or 64 fully-equipped paratroops—and holds the world record for the heaviest parachute-extruded drop, 30,570 pounds.



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ADVANTAGE of composite radar weather possibilities (left) can be seen in comparison with the conventional synoptic display for the same period (right). Synoptic chart shows a stationery front extending from Lake Michigan south into the Great Lakes. Radar display shows this to be a series of small fronts in different stages of development, with an old dissipating system extending eastward. These, and the two other small front systems shown, compared with the synoptic analysis are clearly ahead of the synoptic front analysis. The radar picture also shows that some scattered thunderstorms are reported lines of storms.

U.S. Planning Nationwide Weather Radar

By James A. Fauer

Radar has found a new and significant role in the rapidly growing field of radar meteorology. The technique is expected sufficiently promising for adding better and more accurate weather forecasting to that of Air Force and Weather Bureau scientists planning the establishment of a nationwide network of weather radar and associated data processing equipment to produce "synoptic" weather maps over the entire U.S. The system is expected to be in operation within the next 10 years.

Radar's Value

The value of radar in weather forecasting is that it provides a three-dimensional view of the atmosphere in detecting severe storms, precipitation and related weather events. Its assembling, computer-aided radar returns from a number of radars, large-scale weather phenomena such as storm fronts can be traced and then accurately ascertained followed.

Radar weather observation will not make obsolete more conventional meteorological instruments such as the anemometer, barometer, and anemometer, but will supplement them in preparation

of forecasts. One important use will be both civil and military applications in the extremely rapid penetration of storm areas for testing of high speed jet aircraft.

Joint Project

To meet the modernization program designed to integrate existing and proposed weather facilities, a three agency agreement has been reached between the Department of Commerce for the Weather Bureau, Department of Defense, for the Air Force, and the Federal Aviation Agency that will involve both a national and a global weather system.

The program will be under Air Force direction and is designated by the Air Force as the WS 413-L weather system. Air Force part of it is system will integrate with its WS 403-L weather reconnaissance aircraft system and WS 404-L global reconnaissance system. Radar for the WS 413-L system will be required within the next two years, and the contract built by the time the system is completed near year 1970 within.

For the WS 413-L system was evaluated by scientists at the Air Force Cambridge Research Center to modernize and expand present methods of forecasting

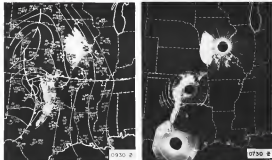
weather information to meet demands by jet aircraft and missiles that require weather data processed by power rapidly than can be done at present. Additionally, the number of weather observations that must be processed is increasing at a rapid rate.

One of the early phases of the WS 413-L program will consist of setting up a test network of one station extending from Boston, Mass., to Norfolk, Va. These stations, located at Air Force, Navy, and civilian airports and airports, will provide an East Coast test center where equipment and techniques will be checked in operation as they are developed.

Observations from all state stations will be sent to a "weather control" where synoptic (large area) weather charts will be prepared at intervals as short as an hour apart. This weather control will be the forerunner of a national weather control that will function with the completed national weather system.

System Development

Radar meteorology as a field of scientific study is comparatively young, dating back to World War II when micro-



TWO METHODS of combining radar weather observations with synoptic analysis are shown above. Presentation of left shows a plotted and analyzed surface chart upon which the radar plus portions indicates display have been superimposed to the location of precipitation echoes is shown with respect to the frontal system. In the presentation at right there are no synoptic weather observations indicated, but the nature of the precipitation echoes is obtained from a series of observations shown by means of sector placed at the proper position. Direction and speed of elements of the storm system are shown.

Network

more radar first detected echoes from precipitating clouds. Since then, a wide variety of atmospheric phenomena has been identified on radar displays: hail, rain, snow, lightning strikes, hot, snow, and freezing rain.

Phenomenon of Echoes

Most recently, the interesting phenomenon of echoes occurred from air has been identified and studied. Some of these echoes appear to be produced by masses of birds and insects, but the majority are believed to be associated with strong temperature or water vapor gradients occurring at wind shear lines, dry fronts, and thermal.

At present, radar weather stations of the Weather Bureau, Air Force, and Navy are used primarily for local operations and forecasts. Their reports are sent by teletype to other regional stations, but no provision exist at this time for assembling and plotting weather observations from widely spaced stations.

Complete radar coverage of the U.S.—except for some weather observation areas left considered essential—will require an estimated 100 stations. As a beginning, the Air Force is presently

completing installation of 10 AN/CPS-9 weather radars, and the Weather Bureau has proposed about 10 WSAR-77 weather radars scheduled for delivery in 1970-71. About five tactical radars will be delivered to the Navy.

Presently all phases of radar meteorology are under study at present, much of this work either is sponsored by or conducted by the Air Force. Scientists of the Complex Research Directorate, Air Force Cambridge Research Center, have concentrated on problems of cloud physics using radar observations to explore the manner in which precipitation forms.

Part of this work has included a broad study of identification of active storms. One result of this study has been the discovery that radar reflectivity of a storm at about the 10,000 ft level provides an excellent indicator of the storm's severity.

Additional Studies

Other study programs include:

- **MIT Radiation Laboratory.** Scientists at this laboratory have looked into the possible penetration of radar echoes in clear air. One possible theory they reviewed was that produced by strong local changes of dielectric constant. A theory was worked out to indicate how strong the gradient would have to be to

for a given wavelength. Basic research also has been conducted on the structure and characteristics of storms.

- **McGill University.** Work here has indicated that radar returns on storm characteristics and development of what is called a constant volume phase-space analysis display. In this presentation, the radar scans at different elevation angles and sections of the scan are assembled to show, for example, cross-sections between 10,000 and 11,000 ft or at the 10,000 ft layer. To do this, radar data must be viewed for two to three minutes before being assembled in a single display as this study includes an analysis of the structure and the morphology.
- **Stanford Research Institute.** Research

Reprints Available

Reprints of Aviation Week's series on weather reconnaissance systems will be available in approximately six weeks. Copies will be billed at the following rates:

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less is natural about the use of composite radar pictures. Working with a complete film file, this work will also develop techniques for analysis of composite pictures, and suggesting ways in which the computer can be controlled by man or computer.

• **Texas A & M.** One of the project members is a study of storage and read out of radar information. A second is concerned with identification of severe storms by radar. One of the approaches being tried is storage and readout in presentation of a single radar PPI picture on a television type display so that it can be viewed continuously in bright light. An elaboration of this system complex radar information, so that radar pictures about 50 min. apart are painted with different color gase—fluorescing producing a display that indicates both motion and intensity.

• **Orion.** Two specialized but intensive weather radar studies in progress are at the University of Miami, exploring hurricane detection, and the Kansas State Weather Service, measuring rainfall and other hydrologic applications.

Composite Weather Maps

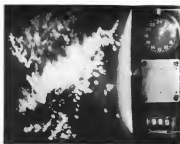
As part of the development of radar reconnaissance, researchers have assembled composite radar maps showing weather radar returns over hundreds of thousands of square miles. These composite photographs are assembled from dozens

of simultaneously exposed pictures of radar plus position indicators showing storm conditions over large areas of the U. S. As a result, meteorologists have found that composite radar weather analysis often fails to provide an accurate and comprehensive picture of the weather. Conventional synoptic maps are prepared on a nationwide basis every six hours. Local stations prepare their own analysis every three hours.

Radar displays, however, are continuous and provide the forecaster with much of the information of current interest. Use of forecasts and location of severe storms, storm velocity, storm height, and violent of conditions within the storm. These last studies of composite radar weather maps have in during the value of the technique and encourage the proposal for a national weather radar network.

A major problem in the storage of data from a nationwide network would be that the data would be acquired simultaneously across the country. It is not possible for all stations to transmit their information to the weather control simultaneously; more probable it will be sent sequentially. Another problem is bandwidth—the enormous amount of information must be transmitted in the shortest possible time.

There is much information in a radar picture that there would be time to



LIGHTNING discharge with indicated length of over 100 mi., is shown on weather radar display. Radar also shows the discharge system as branching structure in the upper left part of the scope, extending from the body of the storm toward the north. The discharge track also appears in 20,000 30,000 ft above the ground, and traveled through clouds at 5000 and 10,000 ft following the main and branching lines.

send. A quality picture would be transmitted to the weather control, but the area of stations selected for the data must be transmitted in a few seconds.

Other problems are:

- **Data accuracy.** The information must be received at it directly at the weather control, and must be stored for immediate or later use.

- **Forecast time.** The manager and forecaster must be able to see the data in the form of a picture, and the data must be analyzed quickly either by humans or computers must be available.

- **Retrieval.** Once the data has been collected and analyzed at the control point, the information must be retransmitted to local area forecasters at a time that will be most useful to them for their own analysis. This must be done at a relatively high speed.

One manner in which radar weather maps can be transmitted is in the form of a bulletin system, where a table of different radar data might indicate in forecasting as they are in use today or in a bulletin form where different variables will indicate different positions, heights and characteristics of the storm.

Because radar shows storm centers by eye, forecasters, they will be able to detect storms in the storm display. This is important because many can develop very rapidly forming storms over one hundred miles long in less than 10 min. Therefore the radar gives a more accurate account of where the storm lies, direction, its extent, and how fast it is moving.

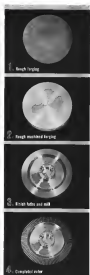
FAA Orders Radar Landing Systems

Washington—Collins Radio Corp., Los Angeles, has been selected by Federal Aviation Agency to provide a new type ground-based radar system for experimental use in automatic and fully automatic landings. The system, scheduled for delivery late this year, will be installed at Newport Aviation Facilities Experimental Center (NAFEC) in Arlington City, N. J.

The Collins system, whose development was originally sponsored by Air Force, offers several attractive features.

- **Flexible glide slope.** Unlike U.S. use, Collins system provides continuous an infinite number of different possible approach angles, making it suitable for handling a wide variety of aircraft types including helicopters.
- **Direct cockpit data.** Lights right next to the cockpit can provide the pilot with direct indication of his altitude and direction position, as well as distance from the runway.
- **Automatic light control.** Cockpit demand signals can be fed into automatic to provide automatic approach and possible landing of aircraft.

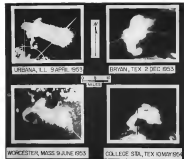
Under the \$381,146 contract awarded by FAA's Bureau of Research and Development, Collins will supply experimental equipment providing only electronic guidance and direction. Equipment will be used to evaluate feasibility of the Collins approach.



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Four examples of radar projection returns associated with hazardous, confirmed by visual observations, taken during 1953-54. Two storms, in Brown and College Station, Tex., were very mild, only slightly more than found clouds. Two tornadoes at Urbana, Ill., and Worcester, Mass., were severe. Black of the echo in the descriptive feature noted on the possible tornado storm indicates for severe or violent.



DOUGLAS RB-45A flying testbed landed down at Washington, D. C., after 1 hr. 36 min. nonstop flight from Ontario, Calif., using General Electric CJ805-3 turbojet powerplants. Acid fueling was not necessary on the 2,295 cu. ft. prop. winged averaged 470 mph. Takeoff weight was 70,800 lb. including 50,800 lb. of fuel. Powerplants are identical to those used on General 800 jet transports, with exception of wind-up systems and thrust reversers. Pilot was R. J. Soles, General Electric chief test pilot, and L. W. Davis, RB-45 project test pilot.

CJ805-3 Has Rapid Acceleration Rate

By Richard Sweeney

Edwards AFB—General Electric CJ805-3 turbojet engines, which power the General 800 jet transport, effectively concentrated their capabilities in Army's new Wings flight simulator test installation at the Douglas RB-45A, which they recently propelled from Ontario, Calif., to Washington, D. C., in 1 hr. 36 min. (AW Jan. 26, p. 47).

Characteristics of the civil counterpart of the military J79, as noted by American Wings pilot while flying the Douglas testbed, were high-lifted by:

- Acceleration from idle to full power at rates which place this engine at the same response category as a piston engine-propeller or the Allison 501D-13 power-propeller. Response rate is substantial, faster than other turbojets the pilot has flown in various military and commercial jet aircraft.

- Simple and reliable air start which, in addition to satisfactory performance within the normal air start envelope, worked satisfactorily at several points well outside the normal envelope.

- Fuel economy which, although less than that from unsaturated gas-turbine powerplants, better than other turbojets of the same class.

In trying to get an accurate picture

of engine performance and relate it properly to other powerplants, a series of dimension factors were considered which are re-examined here due to the magnitude of difference which were observed in flight evaluation, between CJ805-3 and other 70,000 lb. thrust class jet engines.

Turbojets are not supposed to have the same propulsive efficiency at low speeds and altitudes as propellers (driven by reciprocating or turbine engines).

Thrust/Weight Ratio

Thrust/weight ratio of turbojet, aerodynamic characteristics of the airframe, the engine propulsive action dominates all contributed to the air's acceleration gains by the flight test vehicle. Tested at first RB-45A built by Douglas Aircraft, was used in USAF Phase II flight test at Edwards and is later by General Electric for the strictly commercial CJ805-3 program, rather than build.

Despite arrival of much smaller jet, the aircraft was modified for the CJ805-3 program in two ways—piston engines, in pods designed and built by Convair which are almost identical in inlet configuration to RB-45A, are installed; the electrical system was changed to incorporate the General

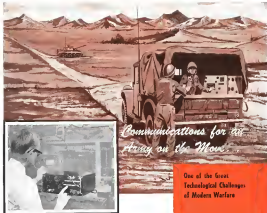
Electric constant speed drives and alternators which are installed on the RB-45A (AW Sept. 8, 1957, p. 38). Thus the turbojet incorporates propellers and piston electrical system components which will be used as the commercial transport.

The RB-45A is basically a non-pressurized turbojet and is intended for flying in a conventional program similar to a standard work which Lockheed Aircraft accomplished with Electric power packages in Elston (AW Oct. 14, 1957, p. 91), and Allison "Open-line" (Hawthorne).

The turbojet does not incorporate the General Electric model supercharger with which the RB-45A is equipped and carried on first flight, nor are three reversers installed.

Two flights were made in the Army's new Wings evaluation program, with the main effort directed toward comparing the CJ805-3 engines which have gained widest attention, primarily acceleration and air intake, plus fuel consumption, although engine test time surprise measurements at the various altitudes was prohibited by the lack of proper instrumentation that was noted earlier.

In the acceleration regime, various throttle displacements, at varying rates, were made at a number of altitudes,



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C180S-2 engine ports are similar to those on the General 180 turboprop. Backup port on top is turbo backup.

especially at high and low altitudes. Additionally, no tests were run through altitudes from 15,000 ft. to 41,500 ft.

Additional acceleration examples were obtained in ILS coastal approach runs at Grand Air Force Base.

C180T-1 acceleration in tactical pattern showed there was to be virtually instantaneous with rapid throttle application. Turbocharged piston engine full power at a manifold, normal power at 95% rpm, roll in started and full power applied after speed is gained.

Thrust Backup

In adding the last element of power, thrust backup was instantaneous with throttle movement in the first and second segment climb, 1800 ft. to full 5 min allowable period was maintained. Takeoff was also earlier [70 sec. C180S are designed for water injection.

ILS approaches are made with gear down, flaps at approach (40%) and speed brakes extended, with full flap extended just prior to reaching the middle marker. Approach was at recommended value for entering gear height. The first approach was made with 280-knot hold above the glide slope until close in, giving a steeper descent and faster rate of descent than would normally obtain, while the second approach was held to the proper height angle. In both approaches, aircraft was then accelerated before the usual accelerated

ILS rollout maneuvers, to maintain engine acceleration and thrust backup relationship when power is applied for go-around late in an approach.

Full power was applied from 6400 rpm, approximate best power level for ILS full approach in existing configuration, and acceleration was maintained with very rapid throttle movement. Turbocharged piston was fast enough that despite immediate gear activation, the speed built up too fast for wheel down to complete, those elements were properly, even with speed brakes remaining extended.

A standard, normal, coastal approach profile, was followed either there is a high angle pullup, which would have held the speed down. Turbocharged piston at light gear height on the order of 44,000 ft., which gave a very good thrust-to-weight ratio.

Engine Performance

Engine performance through both runs with air induction. The turbocharged piston engine, from an engine working on V plus 10 ft with a high angle of attack, completely duty configuration, going out to the region that section is almost equal to a general piston engine.

Thrusts were checked, showed forward and generally evenly spaced according to most engine handling standards. No surges or compression stalls resulted from the sampling done at various altitudes and speeds.

At speeds with C180T-1 an engine speed very simply in those operations—two as fuel boost pump, air start (ignition) switch and fuel control. The gear came from windmill to full in 10 sec and smoothly.

Starts were made in flight conditions above the normal static altitude and below normal speed. In all runs, the powerplant accurately reflected responses of standard speed (1400 ft. to 2100 rpm, or improved low to 285 ft. indicated air speed at static turbo fan altitude of 41,500 ft. in one run.)

Single Engine Test

In the normal, altitude could not be maintained on one engine at the average weight of 45,000 to 52,000 lb. at which several high altitude starts were accomplished. In this case, after the engine had windmilled down to below 30% rpm, the altitude had slipped to about 37,500 ft. at which time a single

was fully accomplished and the engine was returned to the flight path or setting. One start was accomplished at 44,000 ft. with a gusting and right on target at 40% rpm at 186 ft. 145 (Mach .50), a same-but low speed for the altitude. Little altitude was lost since the engine was not allowed to rpm down to low speeds, a time consuming process.

Both engines were, indicated at 37,000 ft. at 40% and 41% rpm, both at 140 ft. (Mach .51), with fuel flow one engine to 5.5 lb. per hr., the other to 7.0



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by Air, and evaluate gas temperature (EGT) held at 410C and 500C.

In almost all cases fuel flow at constant idle speeds remained within plus or minus 2.5% of the 500 to 1:1 value and EGT peaks at idling stayed between 410C and 500C, although the margins were at the level of 450 to 460C.

A component of the CTR55-3 which gets much credit for engine's perfect run is the Woodward fuel control. Among the features of this control is a capability of the engine to be re-started with the throttle set at any position from idle to full thrust at any altitude or speed.

The unit start was demonstrated in which the throttle was left at full open position when the fuel was shut off. To loose throttle shock which would have been incurred if the engine had been allowed to stall completely during the time period required for windmill down to about 225% rpm, the engine was restarted at about 465% rpm. Recovery was normal and the engine moved to idle rpm of about 675% (proper for the altitude) when acceleration had low schedule (over 100) and engine quickly and smoothly moved to 95% rpm which was full throttle value for the altitude. There was no overtemp or heating.

Several similar examples were accomplished by the American West pilot, with throttles set at 91% rpm at 15,000 ft. In several such situations, in which engines were allowed to idle down to about 71% rpm at altitudes of 15,000 to 19,000 ft. and then, right on was re-accelerated satisfactorily. At the lower altitudes and less than maximum power settings, thermal shock, was not as acute as would have obtained at higher altitudes and lower temperatures, since outside air temperatures at the time registered near Centigrade.

In the Woodward controls, a corrected speed indicator is incorporated which prevents maximum speeds and engine temps which might easily be obtained with maladjusted throttle levers and high throttle setting air returns.

Examples of these were done in American West flight evaluation.

This feature was also control gas metering, compressor discharge pressure, compressor inlet temperature, actual rpm and throttle position. The unit, essentially an auto-throttle, functioned to start reducing fuel flow to prevent over-boost and heating as the rpm approached the value called for by the throttle setting. It would in advance on a throttle drop preventing stall from sudden high throttle condition.

As in any turboprop, the CTR55-3 is designed for a certain mass air flow, which is subject to change according to altitude and temperature. To ef-



First Grumman Mohawk Nears Completion

First Grumman Mohawk turboprop Army observation plane is nearly completed on Grumman production line at Ames, N. Y. Army specifies 32 main engine, 1000 hp, 1000 ft. at 10,000 ft. to a contract awarded last April has construction of one prototype which will be tested and evaluated by Navy Bureau of Aeronautics. Now a second Grumman Mohawk contract for the Army. Short takeoff and landing aircraft designed to operate from fields, equipped with a power by two Grumman 1153-5 turboprop engines each rated at 1000 hp. Mohawk has empty loading gear, weight 9,000 lb empty and max weight of 42,000 lb. Overall length is 50 ft. Army designation will be AO-1A.

less desired mass air flow, or in close to it is possible, the engine incorporates a corrected engine speed feature on automatic compressor for altitude and temperature changes.

The unit works to provide the ratio of fuel which would be the proper level of the selected rpm (throttle setting) and altitude on a standard day. When temperature is below normal, the actual engine rpm drops since proper air mass flow is obtained with less engine speed. On a hot day, actual engine speed is greater to make up for the less dense air and still provide the proper or best detectable mass air flow.

Optimum Mass Flow

Reading on the pilot's instrument panel in the proper hypothetical engine speed for the altitude and temperature, although actual rpm may be higher. For example, on a hot day at 37,000 ft., the instrument panel tachometer would read 96% rpm while the actual engine speed is 104% rpm, maximum limit speed for the engine. This will provide extra fuel, extra mass flow, extra rpm the value desired or the closest possible for the altitude and temperature.

The CTR55-3 is convertible a 1997 powerplant, (JAW Aug. 11, p. 61), the West II development stage. However, it is no auto-throttle, but the weight is absorbed in other areas in beefing up the engine's structure for longer service periods between overhaul for commercial aircraft. One area of difference is that while the 1997 unit engine mass is part of compressor case, the CTR55-3 uses a steel case. There is additional structural reinforcement in areas where larger engine life and more reduced maintenance cost, where

weight is not the same criterion it is in a military aircraft.

The current CTR55 program got under way about a year ago when the airplane was tested and flew west into the modification code. Scheduled to fly in October of last year, its first flight on the modified method was made at 430 p.m., Oct. 13 following 10 quick hours of shutdowns in the testbed was delayed to Douglas Aircraft at Long Beach for static test. It was returned to General Electric in Detroit last.

General Electric is tailoring the Edwards AFR flight program to provide a close simulation as possible of actual flight schedules. Flight schedules were outlined after conferences with airline operators who have purchased the CTR55-3 with CTR55-3.

While one engine in the RB 66A is partially unarmored, a fully armored CTR55-3 is installed in the Douglas XF-104 which General Electric operates as a testbed. Engineering test data is derived from the aircraft which runs on one engine and then on two data gathering system. CTR55-3 first flew last April in the Skunk Works, 100 lb. in 15 seconds, then went to General Electric for ground test and testing there. Another CTR55-3 was installed in the XF-104 last September.

In the RB 66A, current engine has accumulated only a few hours. However, about 100 hr. in engine will be installed which usually has been run 1,000 hr. on test stand at General Electric plant in Evendale, O. This powerplant will be run another 1,000 hr. in the RB-66A, it is hoped by October of this year.

Goal of this program is to give

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TEMPERATURE...-65°F. to 1000°F
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 per hr.
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ATMOSPHERE...air, water, salt water,
 jet fuel, exhaust gases, oil, hydraulic fluid
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VIBRATION...40 Gs

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Shown above are a few of the many tough connector problems that have been presented to Cole Electric Co. in recent months. Thanks to the versatility and adaptability of revolutionary new Cole Self-aligning connector pins and their capability under extreme conditions, all of these problems are being solved. Special Cole Connectors have been developed to meet difficult environmental and operational requirements for aircraft, missiles, ground support, computers, nuclear, electronic and electrical equipment.

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practically 5500,000 to build a street too to shield the place from public view. After looking into the matter, Barker and the contractor agreed that the cable required for the job would need to be kept secret from the shape of the engine to which it could be accomplished by building an expansion structure for making the cable at a rate of a few thousand dollars.

With the new exploit, clear-cut decisions of what contractor classified information, Barker expects to profit under the hundreds of requests for investigation which, provided, lead to come to headquarters for a decision, according to Paul Kaufman. Kaufman is assistant to Barker's secret director in classification.

For instance, certain classified equipment must either be placed under 24-hour guard or be removed from an airplane for security. Recently, the question came in from a Navy field facility. When we get in the equipment, must we also remove it? The solution was a black insurance company of the equipment? Under the old policy, the cables might be considered part of the classified equipment. But under the new security guidelines, it is not, so, to establish whether the cables could be themselves moved specifically useful information about the classified equipment.

Aviation Back-Breaker

Instead of applying the new philosophy only to new contracts, Barker decided to apply it to existing programs and equipment now in flight use. Today, one part of this intricate machine as come in Barker's Aviation Division, whose new 10,000 equipments and programs had to be reclassified using the newly established criteria. The program is spearheaded by William Grogan, working with Kaufman's office. Some of the equipments had been developed during World War II, still carried a security classification because no one had gotten around to declassifying them. Approximately 7,000 items were declassified, a number of others downgraded.

Barker considered redesignation of individual subcomponents and items, such as moving equipments in accordance with the new criteria but doing this, took too overclassifying with more than 100,000 items that would have required detailed study.

Theodore Barker will establish security classification levels for subsequent items and many parts only as future contracts. This is to be done concerning with spare parts provisioning. Each contractor will be responsible for reclassifying security classification for individual items parts but recommendations will be made by the Barker security director. Grogan believes that

the bulk of the spare parts will be as classified.

Within the next several months, the business groups to publish a new Barker Classification Guide which will list all new and old items and each into the new classification categories which applies to each. Change in six months each of the classified programs will be reviewed with the agencies.

present agencies to establish whether any change in life cycle categories has taken place. If so, a new security code may be listed in the next edition of the Classification Guide which will be published in a year.

When the first new Classification Guide becomes available in the next several months, Barker will then conduct its new policy to all of its contractors.

AIRPORT REQUIREMENTS*

	Air Base Aircraft ¹	General Aviation Aircraft ¹	Total Pass ²	Refueling Capacity gals ³	Accommoda- tion Rooms ⁴
Air	\$27,000,000	4,400,000	\$10,000,000	\$4,000,000	\$1,000,000
Ala	\$2,000,000	1,100,000	\$3,300,000	\$1,000,000	\$1,000,000
Cal	1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Calif	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Conn	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Del	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
D.C.	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Fla	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Ill	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Ind	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Iowa	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Kan	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
La	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Me	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Mass	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Mich	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Miss	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Mont	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Neb	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Nev	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
N.H.	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
N.J.	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
N.M.	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
N.Y.	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Pa	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
R.I.	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
S.C.	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
S.D.	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Tenn	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Texas	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Utah	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Va	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Wash.	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
W.Va.	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Wis.	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Wyo.	\$1,000,000	1,000,000	2,000,000	2,000,000	2,000,000
Sub Totals	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Air	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Ala	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Cal	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Calif	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Conn	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Del	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
D.C.	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Fla	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Ill	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Ind	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Iowa	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Kan	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
La	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Me	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Mass	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Mich	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Miss	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Mont	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Neb	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Nev	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
N.H.	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
N.J.	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
N.M.	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
N.Y.	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Pa	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
R.I.	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
S.C.	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
S.D.	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Tenn	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Texas	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Utah	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Va	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Wash.	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
W.Va.	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Wis.	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Wyo.	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Sub Totals	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Refueling	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000
Accommodation	\$100,000,000	\$100,000,000	\$200,000,000	\$200,000,000	\$200,000,000

* Comparison by Staff of Senate Commerce Committee
 † Data survey by Federal Aviation Agency

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A good sign to fly with...**AVIATION PRODUCTS****EQUIPMENT****Fuel Unit Would Prevent Contamination**

Several, N. I.—Long range goal of a security program underway at the Shell Oil Co.'s Amosfield Turbine Fuel Equipment Laboratory, here is a full-scale unit that will automatically shut off the pump on a shifting valve to prevent contaminated fuel from entering sensitive turbine engines.

This goal is obviously a distant one, major reason for this is the extremely small size of the solid contaminants the fuel experts hope to stop. Five microns is tentatively set as the upper limit for airborne particles. A photoelectric beam, which was the basis of one of the first of a full-scale unit, proved too crude to handle the problem.

A more sensibly objective is the development of a filter separator that will remove contaminants selectively. There is no filtering unit available today, Shell declares, that stops particles so effectively. A good filter now removes 99% of the foreign particles from aviation fuel, but those that are left still range in size from 1 to 150 microns. What is needed is a filter separator which will take out all contaminants above, say, 10 microns without slowing the fuel pumping rate. This would be a significant step. Meanwhile Shell and others are an ongoing replacement, positive cut-off device.

Until now there have been no requirements set for solid contaminants. Both civilian and military requirements have been based on the government specification for all filter, MIL-1-100A, which simply required the removal of 5 percentage of all contaminants. This specification is generally being rewritten and will probably include particle size limits based on the work now in progress at Amosfield Laboratory.

Shell's interest in the problem stems from its position as an aviation fuel supplier, selling more than 15% of the aviation fuel purchased by commercial airlines. Large, air transportation stops when it pumps the fuel into the air transport storage tanks. Actually, when something goes wrong, Shell declares, the fuel companies are the first to be blamed by the airlines. While Shell has no interest in making fueling equipment, it feels that it is forced to set standards for this equipment to protect the interests of the company.

The problem of turbine fuel contamination is fast increasing in proportion. Now less than 100 million gal./year, the demand for aviation turbine fuel by U.S. airlines is expected to jump to about 1,500,000,000 gal./year by 1962. Moreover, there are many facts to the problem. Mainly in point of these are the following:

- Increased sensitivity of turbine engines to moisture and foreign particles. Over time, there have been instances where solid particles have blocked small passages in the engine, the source of fuel pumps and stoppage of the engine. Few designers, but rapidly changing and more common, are the cases where turbine fuel contamination causes premature failure of parts, requiring an unscheduled repair and maintenance cost. So far, engine sensitivity hasn't really been a problem in the U.S., says Shell, because the Gulfstream III engines which power almost all the turboprop aircraft have not relatively simple. But the introduction of the pure turbojets, the company declares, is going to change that.

- Greater fuel consumption of the turbine engines. Compared to the Douglas DC-7C which burns gasoline at the rate of 150 gal./hr. the Douglas DC-3 and Boeing 747-130 jet transport consume 2,500 gal./hr. of turbine fuel, while the smaller Boeing 707-120 burns about 1,800 gal./hr. This means that the demand for fuel contaminants to feed jet engines are three to four times as great as for piston engines.
- Slower settling rate of turbine fuels.

Settling is an excellent method of lessening fuel contamination and is used, on the average, twice during the course of fuel transfer from supplier to aircraft—once in the storage tanks at the supplier's bulk depot and once in the storage tanks at the jet terminal. At the same time, fuel handlers try to keep settling to a minimum. It takes time and then up costly fuel. And, with the higher viscosity of turbine fuel, settling could require additional storage tanks, increasing costs, according to one estimate, average \$10,000 for a unit of two 15,000 gal. tanks. Standard settling time for aviation gasoline is 15 min. per foot of storage depth. For aviation kerosene, five will have to be lengthened to one hour/foot of depth to achieve comparable levels.

The solution to most of these problems, Shell believes, is the development of a filter separator which would remove all moisture and all solid contaminants above a certain size from turbine fuel without slowing down pumping operation or causing any combustion costs. Each full scale installation of one filter separator runs at the Amosfield Laboratory costs the company \$5,000 to \$10,000. But although no suitable filter has been developed—one will still produce it when a viable company considers the money well spent.



AMOSFIELD experiment pumps contaminated fuel through filter set to basic container.

Steel Honeycomb Brazed Continuously

By Craig Lewis

Dallas—An automated continuous process for brazing stainless steel honeycomb panels has been developed by Texaco Aircraft Corp., and Texaco engineers say it will do the job cheaper, quicker and better than present manual brazing techniques.

With the Texacoforming process, panels are heated in their own furnace at a regulated rate, then are statitically formed to the desired curvature. The furnace and its feed system are flexible enough to handle panels of nearly any possible thickness, length or width.

Development of new processes for

fabricating stainless steel honeycomb panels is significant in view of increasing speeds and complexities envisioned by aircraft of the North American Model 33 B70 and F108 types and the corresponding need for materials to withstand these conditions. There are no production contracts for parts of such aircraft now, but only says that the new system was developed for future concept planes or subsonic twins.

The new process is designed to replace present batch techniques in which panels are made with carbon references loading and require several hours in a furnace to complete the brazing process. Texaco forms themselves large fuselage, carbon loading and the use of large quantities of inert gas, and the company contends that Texacoforming is cheaper in both capital and operating cost. It is also faster than the carbon loading method, and is expected to produce a better product because of fewer joints, according to group engineer A. W. Garvin.

Prototype System

Prototype Texaco system is designed around a strip furnace with two banks of radiant gas infrared burners. Gas flow entering is 4 ft. wide and 15 in. deep. It is set in the middle of a table of rollers, and a chain drive along the side of the table is used to move the panel through the furnace, heating it at a given length.

To ready them for the process, panels, honeycomb core and lining sheets are put together and covered with a common stainless steel cap which is then welded. The envelope is grouted with argon, then processed, and a partial vacuum of 5 psi is maintained throughout the process with the internal argon atmosphere. Pressure of the evacuated envelope has the effect of holding the panel components together.

Panel is clamped in a frame that moves it over the roller table and through the furnace. It moves at three to five inches a minute, and speed of the chain drive is controlled by a thermostat which reads signals to a temperature controlling recorder and controls a variable speed motor.

Speed is varied to maintain an even temperature on the panel and prevent warping.

Front burners preheat the panel to about 1,200°, then the second row of burners heats it to the brazing temperature of 2,500°. Radiating furnace

thermal shock and helps avoid distortion.

The heating zone also puts the panel through the first stage of the heat treat cycle.

After heating, the panel is cooled to room temperature and stretch formed to the proper curved shape. This operation also removes any minor warping that may have developed in the heating process. Texaco applies tension to the panel on an F100 stretch press, loading both ends evenly. A die is then brought up, drawing the panel across its curve and forcing the correct curvature.

Furnace system is on the discharge

stage, and engineers are working on improvements. A change in instrumentation on the production version will add three more thermocouples, and thus will be used to raise and lower the furnace over the panel surface to maintain an even temperature. While this modification is perfected, panels will probably be run through the furnace at a constant speed.

Panel Width

Texacoforming was developed to handle panel widths of 10 to 12 ft. but it can also be used for tapered and other odd-shaped panels. Panel widths in

fact are limited to four feet because that is the width of the furnace, but wider panels can make be accommodated in a production version by widening the furnace. There is no limit to panel length except the physical limitations of the system used to feed the panel to the furnace.

Using induction heating, Texaco has also developed a method for brazing fasteners to panels and for joining them to structure. For fastener positions, panels are cut and a cap is inserted so that fasteners can be inserted cross-sectioned in the panel without causing the laminated structure, using an internal wrenching bolt.

Machine Spins, Roll-Forges Metals

El Segundo, Calif.—Continued advances in metal spinning and roll forming are achieved by a new machine designated Spin Forge. The \$13,000 machine costs \$500,000 and will form sheets up to 3 in. thick and 60 in. in diameter, while reducing wall thickness by up to one-half in a single operation.

The machine offers up new potential in the manufacture of lighter parts for advanced aircraft and ocean designs. Designed and built by Hylfard Corp., a division of the Singer Corp., to Marquardt Aircraft Co. and Aerojet Industries Inc. specifications, the machine is financed by the Air Force's Air Material Command. Spin Forge will be used at Marquardt's El Segundo, Calif., aircraft manufacturing plant.

Advantages of Spin Forge are:

- Ability to produce shapes of revolution such as cylinders, cones, tapers and parabolas in one continuous form.
- Reduction of wall thickness in the forming operation.
- Thicknesses of up to 0.001 in. in wall thickness and diameter for pieces up to 60 in. in diameter.
- Achievement of machined-like surfaces on finished pieces.
- Increases in tensile strength of part, while decreasing density.
- Formation of shapes of revolution without weld seams.

Machine's Ability

During a demonstration, Spin Forge shaped a 60-in. disk of 321 stainless steel, 3 in. thick, into an aerodynamic wedge shape, while decreasing the metal wall thickness by one-half. Entire operation took 78 min. The data also was chosen to prove machine's ability as part of Hylfard's demonstration to Marquardt.

It was emphasized by Hylfard engineers that the metal was not being bent to shape over the mandrel, but was being formed by plastic deformation to the desired contour.

Spin Forge operates like this:

- Rotating drum with mandrel attached, is moved out under material before being fed. Raw stock then is placed on the mandrel. This eliminates need for special handling techniques, since materials can be used.
- Tensile force passes down on work with a force of 200,000 lb. Tensile force also exerts a pull of 100,000 lb. on work.
- Dense metal piece at a speed which is sufficient to cause flow of 10 to 400 psi. The drum is driven by hydraulic motor and has a governing feature which will keep constant speed constant regardless of diameter reduction.
- Metal takes on its final shape and wall thickness electronically in hydraulic actuation for the rollers. The rollers can exert up to 775,000 lb. in either a vertical or horizontal plane. Motors

for each roller is actuated by the system through the electrohydraulic system and computer controls roller position. This accounts for the close tolerances desired for the finished product.

Electrical Heating

Electrical heating processes are provided so that metal which cannot be cold formed can be worked at elevated temperatures.

Provision is being made to install closed-circuit television camera for viewing the work, so that the operator need not move from the control panel. This also protects personnel if the work being worked on an unexpected blow. In certain positions, there is a risk that the work explosive disintegration.

Tensile pressure is reduced, down



STAINLESS STEEL honeycomb panel entered in its envelope and clamped in a slide drive frame moves through the furnace area at Texaco Aircraft Corp. Thermoplastic envelope over the outside one of the furnace regular panel speed to keep heating uniform. Line running from the panel envelope is used to maintain a partial vacuum of 5 psi on the envelope's internal argon atmosphere. Pressure of evacuated envelope keeps parts together.



BURNERS which do heating are under the hood of Texaco's prototype furnace.



SPIN FORGE weighs 400,000 lb., is shown during a roll forming operation using 321 stainless steel. Mandrel is a cone shaped which the stock is forced. Finished product is sheet half of original thickness and has aerodynamic surface.



FORWARD piece shows machine-like air flow. Rollers, capable of nearly million lb. of force, are on either side. Piece is composed of stainless steel.



STRATUS flying template position of struts is transmitted by electrohydraulic means to the rollers.

and mounted on a base from the machine, and a cone rides up the finished part.

One of the most difficult engineering problems in the development of the machine was the design of the hydraulic actuators for the rollers. Halford originally sought help from manufacturers of hydraulic valves. No one seemed willing to tackle the problem of designing valves to handle the 725,000 lb. actuator pressure and a 5,000-psi. system.

Halford solved the problem by designing variable volume pumps and eliminating the need for valves.

Metal Experiments

Experimentation in the working of various metals is still going on at Marquette, including the investigation of what can be done with "exotic" metals.

As an example of what the Spun Forge will do, a conventional (1140) aluminum alloy, in a 57% reduction, emerged with an increase of 68% in tensile strength when tensile elongation decreased from 33 to 5%.

Titanium also can be processed in Spun Forge, according to Marquette. Commercially pure (70,000-psi. yield strength) and 51A1-2 Sbc (140-KT) titanium alloys were investigated, and while all tests were conducted at elevated temperatures (1000-1400°), indications are that the commercially pure titanium can be worked at room temperature. While no increase in tensile or yield strength is gained in Spun Forge titanium, neither is there a loss.

Presently, Halford is dismantling the Spun Forge for shipment and installation at Marquette in Ogden.

Further tests to determine the machine's capabilities in titanium and exotic applications will be conducted. During the work thus far, future production models, Marquette will handle other manufacturers' requirements which are derived the use of the government-owned Spun Forge.

One other machine already is under construction for Halford's use, an entire construction of a third machine will be started shortly for General Electric Co.

Continuous-Path Machine Tool Movements Prerecorded on Tape

Engineered. Cobl-Micro-Path, a simplified system for machine tool control that utilizes magnetic tape to store a preprogrammed path, was demonstrated last by Micro-Path, Inc., a subsidiary of Vapo Industries.

System costs between \$15,000 and \$25,000. Machines may be purchased in several configurations: some units are offered in complete form.

Recording Tape

Micro-Path provides a means of recording continuous-path machine tool movements on tape without use of the usual complex programming equipment. Basic motion can be applied to cutting machine tools as can be designed into new machines.

Recording and playback controls are located on any control panel of machine. Advantages claimed for Micro-Path system include:

- Three-axis motion control necessary for continuous path work, such as precise and constant velocity as well as point-to-point operations such as drilling.
- Greater speeds than manual production methods.
- Accurate location within .001 in. with end-of-travel checks preceding each cutting operation to ensure accuracy of table position relative to program.
- Fully loaded, carbon tape, operating at maximum efficiency on every cut.
- Rapid traverse between cuts with reset feed into an existing operation without loss of time between operations.
- Accurate duplication of parts without jigs or locating fixtures.
- Reduced setup and inspection time and material cost.
- Reduced programming time.
- Elimination of specially trained operators.



Units are produced with Micro-Path control table and bank of eight vertical cutting heads.



General Electric J85 Variations

Three models of the General Electric J85 hydrostatic inboard engine each have a different application. J85-1 is designed as prototype engine for Northrop F-117 supersonic jet trainer. Just behind it is J85-2, powerplant for McDonnell QVM-72 decoy missile, and at right is J85-3, which powers the prototype North American T-37 Stearman.

PRODUCTION BRIEFING

Tapp Industries, Inc. of Los Angeles, has announced formation of U.S. Stainless Corp., a wholly-owned subsidiary, will organize operations of Vapo Manufacturing Co., a division of Tapp Industries.

Switzer Brothers, Inc. of Cleveland, Ohio, will launch the Navy with 30,000 gal. of Du-Glo for orange aircraft paint. Included in the 30,000 gal. is a clear varnish which masks the fading effects of the sun. High visibility paint is intended to aid in the prevention of mid-air collisions.

Cleveland AeroSpace Assn., a group formed to bring more aircraft contracts to the Cleveland Ohio area, has appointed Gloria G. Anderson as group administrator. Anderson, employed by the Cleveland Electric Manufacturing Co., will be "in line" to the north based organization to guide its actual operations.

Standard Railway Equipment Mfg. Co., Chicago, Ill. will produce 1,200 ft. of steel blast fraying for installation of belts A18, Ph. Blast force, to be placed at regular intervals to 100 ft. lengths, will be solid sheet steel, 10 ft. high.

SKY Industries, Inc., Philadelphia, Pa., has acquired Reed Instrument

Co., Los Angeles, Calif. Reed, operating as a division of SKT, will bring the bearing corporation into the aircraft superlubrication and engine bearing field.

Teknospacing Corp., Los Angeles, Calif., will build and equip a test facility for Pratt & Whitney engines under 5981,116 contract. Valves, produced by the respondent's Whittaker Controls Division, are used in the sub-wing system of the J57 turbojet engine.

Follows contracts for component production in Boeing B-707 variable platform basins have been awarded to Vance Aircraft Corp. (57 million) and Goodrich Aircraft Corp. (52 million). Trench will continue construction of 75-ft. aft fuselage section. Goodrich is building main wing section and top porch at its Littlefield, Ariz., plant.

Reliance Power Division of Bendis Aircraft Corp. will start production of air data computers for McDonnell F-101 and Republic F-105 fighter jets, on the basis of a \$9,440,417 contract awarded by U.S. Air Force. Seven computers have been ordered for Century F-102 and Century B-1.

Royal Netherlands Air Force has ordered two Bad Aeronaut Alouette helicopters. Delivery of the machine provided aircraft will be completed in summer.



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ably died from drowning. Further, the lack of extensive craniofacial malformation, together with the general condition of the bodies, suggested that the water aspect, if though active, was not sufficiently great to

Life preservers were found on 14 bodies, two of them children. One of the recovered bodies, wearing a life preserver, was one of the stewardesses who was still strapped by her safety belt to a seat.

Swimsuits and slippers on the thighs of the captain's and the power's bodies indicated that their sex roles also were lost at the

time of impact. Similar indications were lacking on other bodies. The medical examination further disclosed that none of the bodies had been subjected to fire before or after impact.

As part of the pathological examination, a series of tests for trace material was conducted. Initially these tests indicated elevated levels of carbon monoxide in several of the recovered bodies. This preliminary finding indicated (1) the need for further corroborating tests, and (2) that a study should be undertaken to determine how high concentrations of carbon monoxide could have

Watches Recovered

Five increased wrist watches were examined by a competitive north maker to establish an approximate time of impact. Of these two had been stopped by impact at 35 and 37 min past the hour, respectively.

Two were automatic winding, shockproof and waterproof, and one of these was still running during the covered time when recovered. The other was full of water and

and stopped 15 min past the bus zone. The "waterproof" case was intact and showed no physical damage. It was concluded that it fit for some time before being stopped by water-tighting it. The remaining satellite, which had a nonwaterproof case, had stopped at 25 min past the bus and had water inside. This was considered to be the probable cause of leakage. Considering the waterproof integrity of the case of the search, the first 15 min past the bus and almost the case still showed a probable time of 20 min past the bus zone. The second 27 min past the bus. Since the search had reported at 9:04 and did not report, it scheduled, it 9:14 the time of the crash is concluded to be less than 30 min.

An engine was made of 80 copper alloy castings from N 90944. This included covers of the piston, connecting rods, and all accessories. A detailed drawing of these pieces, which were adequate such as gaskets, showed that it was worthless. Besides, had Zima complied with what he has known previously, it would at the time the motor was dispatched on this flight. The aircraft, a Boeing 777-300ER, was manufactured by the Boeing Co. on Aug. 16, 1990. Two Airframes were used: #1 on Sept. 7, 1990 and it had been approved as an engine service unit that date. It had been progressively maintained and was currently airworthy.

Progressive multifocal degeneration is a serious sensory neuropathy of the optic nerve divided into subtypes on the basis of the pattern of involvement of the optic nerve.

Populites installed on these engines were Hamilton Standard model No. 44444-149. Blade model 70438-2. The populites showed that incorporation of the recently developed speed sensitive patch lock to maintain an constant engine overspeed. The blades were used also. All blades and bolts of all such populites had been overhauled and

maintained in complete secrecy until, now, Records of the covert fleet of Boeing 577s in the Pacific-Northwest Division were examined and revealed that no propeller aircraft flights had occurred since the adoption of this model propeller. None of the propellers in this particular aircraft had been involved in any catastrophic incidents. Each engine was equipped with a "hot" start device, provided CRJ-100/120-propellers. These provided protection for the cabin air conditioning system as well as the engine superheating.

Load: None

On Sept. 11, 1997, when N9194 was on a trip from Honolulu to San Francisco, the crew faced a land mine. It was described as rare in that it happened on the negative side of the flight deck. The captain made a check of the lower seat of the cockpit and the forward cargo compartment. A considerable amount of a floor hatch in the cockpit. The antennas were checked through the cockpit and every thing was found normal. This incident was written up on the flight engineer's log. [The regulatory agency] and the national airport was a fine letter, but the check was approved by the captain prior to landing at San Francisco. This was accomplished by extending the gate and requesting a visual check to take personnel. No damage was observed and a good landing was made.

Since this incident was written up as a discrepancy, it required an inspection which was signed off with the following action by a company inspector: "Inspected aircraft and found no damage evident." Meanwhile, the industry's regulatory aspects of the accident. Based on several factors, questioned the company inspectors who signed off the discrepancies. The statement of actions taken follows: "Imperfed lower wing and forward wing components, also sections of struts; found you could duplicate load test by stepping load in one between in front and rear; find load being could be duplicated by dropping forward toilet into fuselage; damaged floor."

No further damage noted.

Fixed investments

The last preflight inspection was started on Nov. 6, 1917 and continued until the date of departure, Nov. 8, 1917. All discrepancies had been checked and signed off by appropriate maintenance personnel.

During the course of the investigation, and in view of the circumstances of the disappearance of the aircraft and the absence of living witnesses or true witnesses, as a further investigation of personal attributes and backgrounds of true passengers and company ground personnel of the San Francisco base of PAAFA was made by CAG and other governmental agency personnel.

This investigation included personal interviews with all personnel who might have had access to the aircraft log and memo while the aircraft was on the ground on its last departure from San Francisco June 6, 1937, to June 8, 1937, and involved some 90 persons. This phase of the investigation

disclosed that the aircraft received normal preparation for the flight and disclosed nothing relating to the clearance or behavior of any person that might point to sabotage in connection with the loss of the aircraft.

Specific Maintenance

Subsequent to the public hearing the Board conducted an investigation of specific maintenance and medical practices and procedures at the centers. San Francisco has the purpose of the investigation was to obtain information in which maintenance adequacy of the carrier's Boeing 737 aircraft and personnel could be judged, consequently, a part of the investigation is limited strictly to these aspects.

A number of regulations in mortgage procedures and/or practices were noted. However, because the system was not set up with an mortgage giving any clue as to the nature of the mortgage and because there was no direct application of these regulations to 544 it is difficult as possible to associate them with, or discuss with them from, the system.

The subjects of emergency procedures, and crew training and competency theory, were investigated. It was established that the company's emergency training controls, including drills, fire lighting and smoke evacuation procedures, were adequate and that all crew members of N 9044 had satisfactorily completed the various courses.

It is obvious from the methodology portion of the report that as much as we have at the probable cause of the accident is not really handicapped by the scarcity of physical evidence. However, the following sound logical.



Convertible Jets for VTOL Aircraft

Use of unsuitable fire engines is officially proving sufficient proof for serious health and environmental, low-weight population for forward cruise flight is being studied by General Electric's Flight Propulsion Laboratory Department Cincinnati. Ohio. Propulsion director General Electric J.B. Johnson, would start hot gas to a turbine during use or cruise, bring them to vertical shutdown and landing, low level flight, the engine would be connected to power a conventional General Electric engine. Values in the duct and engine turbine would be measured. General Electric J.B. Johnson, would start hot gas to a turbine during use or cruise, bring them to vertical shutdown and landing, low level flight, the engine would be connected to power a conventional General Electric engine. Values in the duct and engine turbine would be measured. General Electric J.B. Johnson, would start hot gas to a turbine during use or cruise, bring them to vertical shutdown and landing, low level flight, the engine would be connected to power a conventional General Electric engine. Values in the duct and engine turbine would be measured.



Rolls-Royce Conway Mounted on 707-420

Fast-Rolls-Rover Conway turbojet engine, rated at 17,000 lb. thrust, is mounted on Boeing 707-420 subsonic transport being built for British Overseas Airways Corp. The 707-420 is the first of 19 turbojets ordered by BOAC. Conway engines also will be used on 707-420s ordered by Lufthansa, Swiss Airlines and Air India International.

In the aircraft and accordingly 'signed off' the supersonic boom. The normal fixed landing was followed by an supersonic which was repeated briefly by the supersonic machine in the centre of the flight as disclosed that the aircraft entered normal preparation for the flight and disclosed nothing relative to the clearance or location of any points that might point to sabotage in connection with the loss of the aircraft.

Specific Maintenance

Subsequent to the public hearing the Board conducted an investigation of specific maintenance and structural problems and weaknesses at the center. Lita Francisco was assigned the task of conducting an investigation to obtain information to which maintenance adequacy of the center's flooring, 177 aircraft and port operators need to be evaluated, and to determine the maintenance at land church in this article.

A number of suggestions on maintenance

Final Inspection

The last preflight inspection was started on Nov. 6, 1937, and continued until the date of departure, Nov. 8, 1937. All those required had been checked and signed off by the appropriate maintenance personnel.

The subjects of various procedures, and drive training and competition, therefore, were investigated. It was established that the computer, electronic training devices, including Charles' live fighting and mode simulation procedures, were adequate and that all three conditions of N 9044 had no readily detectable effect on the system.

It is obvious from the epidemiologic picture of the report that an outbreak is rare at the published rate of the accident is usually accompanied by the number of cases of evidence. However, the following cases have occurred:

At a high rate has had occurred as the rate of the accident is usually accompanied by the number of cases of evidence.

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Acoustics

BS or MS in Engineering or Physics with 5 to 8 years' experience in the analysis of the stability and performance of powered control systems for aircraft or missiles. Responsible for application and development of active techniques for the stability analysis of powered control systems, auto-pilots, weapons delivery systems and missile guidance systems.

Dynamic Analysis Methods and Advanced Development

MS in AE, ME, Physics, Applied Math with emphasis in dynamics or equivalent in experience. Investigations in unsteady aerodynamics loading on missiles and aircraft in supersonic and hypersonic flow, thermoelastic effects on stability, control, vibration and flutter of high speed configurations; response of aircraft and missiles to transient, random and other time variant loads such as gusts, blasts, atmospheric turbulence, wind shear, noise, landing loads, dynamics of a critical and space vehicles.

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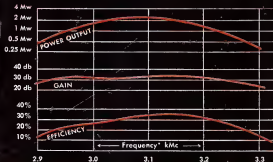
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